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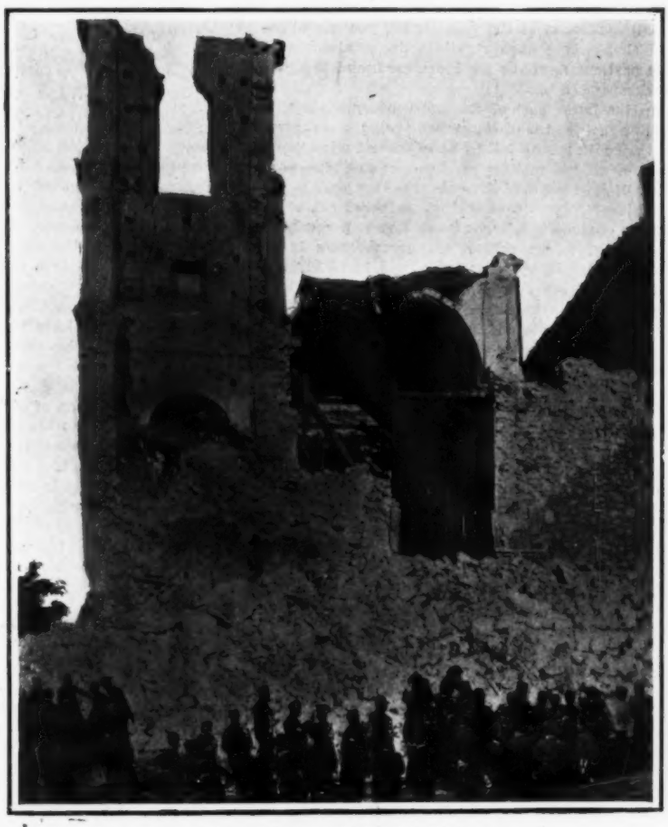
TAKING REFUGEES ABOARD STEAMERS IN MESSINA HARBOR.

SURVIVORS ON THE QUAY OF MESSINA, WAITING THEIR TURN TO EMBARK.



A DEMOLISHED CHURCH IN MESSINA.

By courtesy of Illustrated London News.

THE RED CROSS ON THE SCENE OF THE EARTHQUAKE.

THE ITALIAN EARTHQUAKE.—[SEE PAGE 71.]

MODERN WORKSHOP PRACTICE.*

THE EFFECT OF THE NEW STEELS.

BY R. E. L. MAUNSELL, M.A., M.I.M.E.

AS REGARDS the subject of high-speed steel, the author wishes it to be clearly understood that mere recitals of results obtained from different brands of this steel have been studiously avoided. A great deal of the so-called information that has been published on this subject is most misleading. No good can be arrived at by publishing such results unless accompanied by a very detailed account of the exact conditions prevailing in the shop where such results were obtained, and by full particulars of the machines used, and the class of work operated on.

In the latter part of the last century an intelligent visitor going round any well-equipped engineering works could hardly fail to be impressed with the slowness of all the motions going on round him, particularly if he compared it with the hum and bustle of machinery in woodworking establishments. Who, among engineers, has not given hours, perhaps years, of thought to the subject of improvements in metal cutting, with its speed varying from 10 to 30 feet per minute, and often averaging less than 20? This terrible limitation in cutting speed, which seemed to be an insurmountable one, was, as is well known, due to the frictional heating of the carbon steel tool and its consequent softening by the drawing of its temper. Some improvement in this respect was made when the so-called self-hardening steels were introduced, but practically no very considerable increase in speed was obtained, and the improvement chiefly lay in the fact that these tools kept their cutting edge longer than carbon steel tools when cutting hard material.

About the beginning of the present century, however, a new era dawned on engineers, and suddenly there appeared in the open market, first in America, and quickly afterward in Europe, various brands of high-speed tool steel, which gave results that had often been hoped for, but which had previously seemed impossible.

When high-speed steel made its first appearance, it was confidently prophesied by many people that it would bring about a revolution in all metal-working workshops. A new invention, however, does not bring about revolutions so easily, but, undoubtedly, the introduction of high-speed steel has already had very far-reaching effects in the engineering industries of the world. There is also no reason to suppose that finality has been reached. Changes are being effected which give promise of greater things than have already been accomplished, and there is every reason to believe that the promise will be fulfilled, as alloy steels are only in the beginning of their development.

The credit of the discovery of what is now generally known as high-speed steel is undoubtedly due to Messrs. Taylor and White, employees of the Bethlehem Iron and Steel Works, Pennsylvania. They found out (possibly by accident) that the older and well-known self-hardening steels, such as "Mushet," could, by subjecting the cutting edge to a very high temperature, and then, without allowing it to become cold, subjecting it to a lower temperature, be made to cut some materials at a much higher speed than had ever before been found possible.

It was, of course, well known that to subject ordinary carbon tool steel to such temperatures as 2,000 deg. F., would mean its absolute ruination, and it was, therefore, evident that carbon, the most important constituent in ordinary tool steel, was only of secondary consideration in self-hardening steel, and that it was by virtue of some other special constituent that the latter could retain its hardness at high temperatures.

Further experiments on these lines soon made it clear that it was the proportion of tungsten, and in a lesser degree, that of chromium, that makes the difference between the ordinary self-hardening steel and high-speed steel. By working on this knowledge, and making many patient and costly experiments, steel manufacturers have now placed on the market a high-speed tool steel which gives results that are nothing short of marvelous, when compared with the results obtained from ordinary carbon and self-hardening tool steels before the introduction of their formidable rival.

A great drawback to the high-speed steel of the early days was the cumbersome method of hardening the tools made of it. To obtain the best results it was necessary to heat the tool to a white heat, and quickly reduce it to a dull red, which was accomplished by plunging the nose of the white-hot tool into a vessel containing molten lead. This, coupled with the difficulty of persuading toolsmiths of the necessity of bringing the tool to a white heat in the first instance, led to the system of returning tools to the makers when reforging and rehardening became necessary. Such difficulties are, happily, no longer a bar to development of the use of high-speed steel. Improvement in manufacture has rendered the handling of a high-speed tool a comparatively simple process, and time has overcome the very natural reluctance of the toolsmith to abandon that experience which, prior to the advent of high-speed steel, had taught him that tool steel heated beyond a bright red was absolutely ruined.

ANALYSES SHOWING THE DIFFERENCE IN CONSTITUTION OF THE THREE DIFFERENT CLASSES OF TOOL STEEL.

	Ordinary Carbon Tool Steel, Per Cent.	Self-Hardening Tool Steel, Per Cent.	High-Speed Steel, Per Cent.
Carbon	1.04	2.4	.67
Tungsten	—	5.62	18.90
Chromium	—	.49	5.47
Manganese	.25	1.90	.11
Silicon	.145	.71	.034
Sulphur	.012	.031	.029
Phosphorus	.022	.035	.013

The introduction of high-speed steel into a workshop equipped with machine tools that are reasonably well adapted to the work required under conditions previously prevailing, is a matter that requires very careful consideration. It is obviously impossible to set about wholesale scrapping of costly machinery in order to replace it by a new plant of heavier machine tools, designed to meet the new conditions and to obtain the full advantage of high-speed steel. Such drastic methods are, we are led to understand, the recognized up-to-date practice in America, but they have not as yet been adopted in this country.

The problem, therefore, that presents itself is this—is it possible, if existing installations are utilized to the best possible advantage, to cheapen the cost of manufacture by the introduction of high-speed steel costing about 150 per cent more than ordinary tool steel? The answer is, that the problem cannot be satisfactorily solved without an intimate knowledge of the conditions prevailing in the workshop under consideration. It is quite possible to imagine a combination of circumstances, such as insufficient driving power, antiquated or lightly-constructed machine tools, peculiarities in the articles manufactured, either as regards shape, or the material of which they are made, in which the introduction of high-speed steel would be of no advantage whatever. Such cases are, however, the exception, and in the vast majority production can be cheapened, more or less, according as the existing machine plant and workshop conditions lend themselves to the alterations necessary to secure the best results.

Fortunately, the majority of existing machine tools are capable of being "speeded up" considerably beyond the capacity of carbon-steel tools, and some machines can be altered and improved at a comparatively trifling cost to permit of their being "speeded up" even to the limit of high-speed steel. For instance, many old drilling machines by English makers are so well and rigidly designed, that by substituting a positive feed for the old belt-driven gear, and possibly replacing existing cone pulleys by cones having fewer steps and wider faces, a really serviceable high-speed machine may be produced, capable of getting through three or four times the amount of work possible before alterations. Improvements of a similar nature can also, in some cases, be applied to lathes and other machines with advantage, provided always that the machine so altered was strongly and rigidly designed in the first instance.

Such alterations as those above referred to must be carefully considered before being put into effect. There are cases where it is possible to evolve a good and serviceable high-speed machine from a machine built many years before high-speed steel was thought of, but, on the other hand, it is quite possible by injudicious alterations, not only to waste money in the attempt to increase the capacity of a machine, but actually to render the machine less efficient that it was in its original state. For instance, it is obviously useless to fit a lathe with a new fixed headstock having larger cones and stronger gearing, and to find when it has been so fitted that the saddle and slide rest and movable headstock are too light for the heavier duty which the altered lathe is expected to perform. Or again, to increase the speed and fit a positive feed gear to a drilling machine, and find that the frame is so light that the drills are frequently broken by the excessive vibration set up. When fitting a new patch on an old garment, the tailor must be careful to see that the material in the garment is sound and good, but he must exercise still more discretion when he is aware that the garment will, in the future, have to stand more severe wear and tear than it had previously been subjected to.

High-speed steel, like most other things, will only give satisfactory results when working under suitable conditions. In many cases, disappointment and loss of time and money have been experienced by attempting to utilize it on unsuitable classes of work, and in unsuitable machines.

A frequent cause of disappointment is carelessness in hardening. Although the consensus of opinion is that the forging and treatment of high-speed steel is much simpler and is accomplished with less risk than attends the same process in the case of carbon steel, care and appliances are necessary to insure the best results. High-speed steel tools may be forged in the ordinary way from a blacksmith's fire, but when possible, as it is in most cases, it will be found best to dispense with the forging operation altogether, and shape the tool from the bar by means of grinding only. The object of this is to obviate the necessity of hammering the steel, which has been proved to be distinctly injurious.

When the tool has been shaped and sharpened, the next operation is the hardening, and on this depends the efficiency of the tool. The cutting edge is brought to a white heat, almost to melting point, and cooled in a strong cold-air blast. This operation, simple as it seems, requires considerable experience and skill.

It is an established fact that there is one critical temperature for each composition of steel which gives the best results, and that a small deviation above or below that temperature will greatly affect the life of the tool. It depends, therefore, on the judgment of the operator whether the tool is properly heated or not.

The long practised method of judging temperatures by the eye is unreliable, because the eye is greatly affected by continued exposure to high and bright heats, and to remedy this there are now on the market tool-hardening furnaces fitted with a pyrometer, or a thermal gage, which indicates the temperature of the furnace. This is undoubtedly a step in the right direction, and when the apparatus becomes better known and has proved itself reliable, it will become the most important item in a toolroom equipment.

It will be found most desirable to avoid frequent changes in brands of high-speed steel used in a shop. Such a practice is quite unnecessary, and has a most unsettling effect, not only on the man responsible for the hardening of the tools, but also on the men who use them.

When high-speed steel is being first introduced into a workshop, it is quite necessary to make some experiments with the various brands of first-class steels. It will be found that some steel gives decidedly better results on cast iron, while others are superior while cutting mild steel, and so on; and the management must decide which is, on the whole, the most suitable for the shop requirements. Once this important point has been decided, nothing should warrant a change being made, except the clearest possible proof that a vastly superior article has been placed on the market.

One point never to be lost sight of in connection with high-speed steel is that it will not stand any shock or jar due to excessive vibration. Nothing has demonstrated this more clearly than various futile attempts that have been made to increase the output of the ordinary pattern locomotive tire-turning lathes, by substituting high-speed steel tools for the self-hardening steel tools previously used. These tires are frequently found to have hard spots, due probably, in most cases, to improper mixing in the original casting of the tire ingot, and sometimes said to be due to the action of the cast-iron brake blocks. We are not, however, concerned with the cause at present, and it suffices to say that such a state of things exists. When the cutting tool meets one of these spots, excessive vibration is immediately set up in the lathe, which invariably results either in the head of the tool breaking off, or the cutting edge being so damaged as to render the tool useless until it has been re-ground. In order that the advantages of high-speed steel may be available for tire-turning operations, the Niles-Bement-Pond Machine Tool Company, of New York, have produced a tire lathe that is a marvel of power and rigidity, and a similar lathe is also now being manufactured

* Read before the Engineering and Scientific Association of Ireland.

by some English firms. The author has had the opportunity of seeing one of these lathes at work in the works of the Great Western Railway Company at Swindon, where the output of one lathe averages nine pairs of 3 feet 6 inches diameter carriage wheels per day. This latter is a good illustration of the advantage to be obtained by the use of high-speed steel under suitable conditions, particularly when compared with the performance of an ordinary tire-turning lathe in the same works, a good average output for which is three pairs of 3 feet 6 inches diameter wheels per day.

It is interesting and important to notice the changes in the methods of manufacture that have followed in the wake of high-speed machine tools. Until quite recently the recognized practice in the production of wrought-iron or steel articles was to bring such articles to a highly-finished state in the smithy, and to leave only sufficient material for machining on those parts of the forging where a finished surface was absolutely necessary. The cost of producing such highly-finished forgings was necessarily high. Work of this kind could only be given to a high-class, and, consequently, highly-paid smith, who had with him always one, and often two or three helpers, according to the size of the job. Several heats were necessary before the finished article was evolved from the bar, or rough forging, as the case might be, and the fuel consumed was a considerable item of expense. It was not uncommon in such cases for the smith to have practically the exclusive use of a steam hammer and hammer boy. This method of production, and, I regret to say, the high-class smith who produced the work, are becoming things of the past. The modern high-speed machine tools are slowly but surely taking the place of the highly-skilled smith, as experience has conclusively proved that the finished article can be more cheaply and accurately produced by machining the surplus material from a rough forging, or even from a solid bar or billet, than by bringing the article to practically its finished shape on the anvil before it is sent to the machine shop.

What has been said of forgings is almost, but not to quite the same extent, true of castings. The highly-finished and exceedingly-costly patterns, with their elaborate coreboxes, are passing into oblivion. The system of coring out every possible hole or passage in a casting in order to reduce the subsequent machining operations to a minimum, no longer obtains. The modern high-speed drilling machine, capable of putting a 1-inch hole through 2 or 3 inches of cast iron in one minute, is a very rapid coremaker; and the foreman molder recognizes also that the modern system has the additional advantage of reducing the number of defective castings and "wasters" due to shifting and broken cores.

An interesting change is now taking place in the design of modern machine tools which is altogether due to the introduction of high-speed steel, and which is independent of the increasing size of gears, or the strength or rigidity of beds and frames, these latter being, of course, essential alterations to meet the increased stresses set up by the high speeds and the heavy cuts.

Prior to the introduction of high-speed steel, it was generally considered profitable to have certain machines such as boring mills, slotting, milling, and drilling machines so arranged in a shop, that one man could look after two or even more machines. In order to meet the prevailing conditions and to economize floor space, machine toolmakers embodied this idea in their designs, and built machines with duplicate and often triplicate heads or tables, as the case might be. Under old conditions the advantages of such machines were exceedingly doubtful, except under certain special circumstances, but under modern conditions the author has no doubt whatever that they are exceedingly inefficient. The object to be aimed at in the modern machine shop is to obtain the maximum output from each machine, and this is not possible if a man is obliged to stop one machine, or one head, or table of a duplicate machine, while he is taking down or fixing up a job on the table of another. The single-spindle high-speed drill of the present day is quite sufficient for one man to look after if he is to obtain the maximum output from it, and the same remark applies more strongly to such tools as slotting and milling machines. Machine toolmakers have now recognized this, and are altering their designs accordingly.

SENDING PICTURES BY WIRELESS.

TRANSMISSION OF HANDWRITING, DRAWINGS, AND PHOTOGRAPHS THROUGH THE AIR.

BY DR. ALFRED GRADENWITZ.

THE telegraphic tranmission of handwriting, drawings, and photographs is engaging the attention of scientific men in various parts of the world. In addition to the well-known method devised by Korn, several others of equal promise are being put forward and interesting results may soon be expected.

A method of *wireless* transmission of pictures and manuscripts has been laid before the Royal Academy of Barcelona by J. G. de Guillen-Garcia, and is briefly described below.

In wireless, as in ordinary transmission, a distinction must be made between manuscripts and drawings, on the one hand, and photographs, on the other. In either case, however, the sending and receiving apparatus includes cylinders which rotate synchronously in contact with styles moving uniformly in straight lines and therefore tracing helices on the cylinders.

The style and cylinder of the sending station are connected in series with a battery and a relay, by which the circuit in which the aerial waves are generated is opened and closed, and the style of the receiving station takes the place of the style of the Morse instrument used in wireless telegraphy, and traces lines of length proportional to the duration of the train of waves.

The sending apparatus for manuscripts and drawings is indicated by Fig. 1, the sending apparatus for photographs by Fig. 3, and the common receiving apparatus for manuscripts, drawings, and photographs by Fig. 2.

At the sending station (Figs. 1 and 3) the circuit includes the rotating cylinder *d*, style *e*, battery *P* and relay *g*. The relay is so arranged that it closes the circuit of the coil or transformer *b* and thus gives rise to sparks in the spark gap *o*, and hence to Hertzian waves, when the circuit *f* is open and no current passes through the style and cylinder.

Manuscripts and drawings are copied in a thick insulating ink on the surface of the metal cylinder, so that the passage of each line beneath the style opens the circuit, and consequently, through the operation of the relay, closes the spark circuit and causes aerial waves to be emitted by the antenna *A* (Fig. 1).

At the receiving station (Fig. 2) the aerial waves received by the antenna *A'* effect the closure of a local circuit through the battery *P'*, style *e'* and cylinder *d'*. The style is made of steel and the cylinder is covered with paper which is moistened with a solution of potassium ferrocyanide. This solution is decomposed by the current and the style traces a blue line during the passage of the current. The length of this blue line is proportional to the time during which aerial waves are sent and received and is exactly equal to the effective width of the insulating line of the drawing which, by its passage under the style of the sending station, caused those waves to be generated, provided that the two cylinders are accurately synchronized and are of equal dimensions. The result is that the original drawing or writing is reproduced at the receiving station in short parallel blue lines, 1/20 inch apart, which distance represents the pitch of the helix.

The design can be transmitted on an enlarged or a reduced scale by making the diameter and pitch of the receiving cylinder larger or smaller than those of the sending cylinder. Other solutions may be substituted for the potassium ferrocyanide, or the design may be drawn mechanically instead of chemically, by the addition of an electromagnet which will press the writing point on the paper during the passage of the current. The cylinders may also, as in the gramophone, be replaced by disks, over which the points move in spiral lines.

For the transmission of a photograph, a relief or photogravure print, either positive or negative, is made in bichromated gelatine or similar material, and applied to the surface of the sending cylinder *d* (Fig. 3). (In this diagram the cylinder is shown in cross section and the elevations and depressions of the gelatine film are greatly exaggerated.) The style *e* is attached to one end of the lever *t*, which is pivoted at *u*, and bears at its other end a small wheel *r*. As the cylinder revolves the style alternately sinks into the depressions and is raised by the elevations of the print, causing the other end of the lever to rise and fall and the wheel *r* to roll over a series of contact pieces. The contacts *x* x^1, at each end of the series, are of non-conducting material, while the intermediate contacts, *a* a^1 a^2 a^3, are of metal and are connected by wires with an equal number of metallic disks, *c* c^1 c^2 c^3. These disks are mounted rigidly on an insulating shaft which rotates with uniform velocity. The edge of the first disk is smooth, while those of the others show indentations and elevations, uniformly spaced on any one disk, but varying from disk to disk in such a manner that the aggregate length of the elevated portions diminishes progressively from the second disk c^1 to the last c^3. As the disks turn, their elevations come into contact with a metallic cylinder *z*, which turns at the same rate. One pole of the battery *P* is connected to this cylinder *z*, the other to the lever *t*. As this lever rises, falls, or remains motionless, according to the variations in the thickness of the relief print passing under the style *e*, the wheel *r* touches one or another of the contact pieces and closes the circuit, intermittently, through the corresponding indented disk and the cylinder *z*, the degree of intermittence being determined by the character of the indentation and the first wheel producing a continuous current. As the current in this circuit controls the sparking circuit, by means of the relay *g*, series of sparks and of aerial waves of varied intermittence are generated and these aerial waves cause the style at the receiving station to trace a broken line of a varying width determined by the thickness of the part of the print that is passing under the sending style. As this thickness varies with the light and shade of the various parts of the picture the result is a half-tone reproduction similar in character and effect to the ordinary "process" print. And it is evident that the relief print, whether positive or negative, can be made to yield either a positive or a negative copy at the receiving station, by changing the order of the disks *c* c^1 c^2 c^3 at the sending station.—Révue des Sciences.

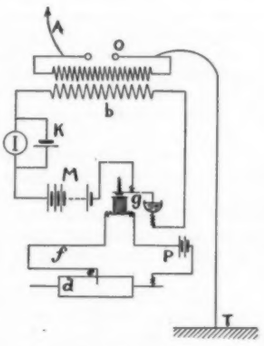


FIG. 1.—SENDING APPARATUS FOR MANUSCRIPTS AND DRAWINGS.

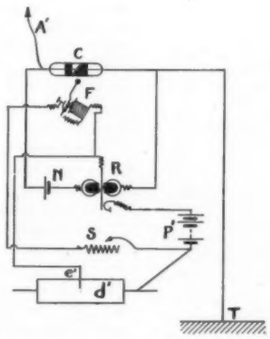


FIG. 2.—RECEIVING APPARATUS FOR ALL PICTURES.

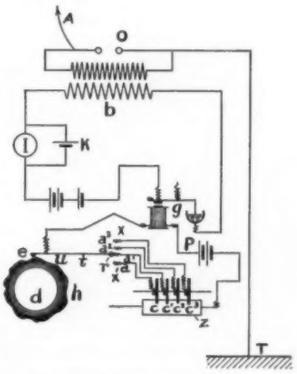


FIG. 3.—SENDING APPARATUS FOR PHOTOGRAPHS.

d, d'. Sending and receiving cylinders. e, e'. Sending and receiving styles. p, p'. Battery. g. Relay. A. Antenna. O. Spark gap. b. Transformer. h. Gelatin relief. t. Lever pivoted at u. a, a^1, a^2, a^3. Metal contacts. c, c^1, c^2, c^3. Metal disks x, x'. Non-conducting contacts. z. Metallic cylinder.

FORM AND STABILITY OF AEROPLANES.*

RESEARCHES SUPPLEMENTING THOSE OF LILIENTHAL AND LANGLEY.

BY W. R. TURNBULL.

THE crying need to-day of aeronautics (considered as a science) is research work, and it is simply amazing when one considers the thousands of scientific workers in all parts of the world devoting their time to

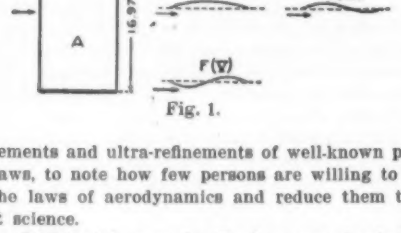


Fig. 1.

refinements and ultra-refinements of well-known physical laws, to note how few persons are willing to take up the laws of aerodynamics and reduce them to an exact science.

The field that is open is alluring, even fascinating, and there is more scope for original research, and more chance for reward than in many of the beaten tracks; and yet the student of science still holds aloof, preferring to pass and repass over the footsteps of others.

Just as soon as the mechanical engineer can command at his designing table full data concerning the lift, drift and center of pressure of aeroplanes, the thrust and efficiency of different forms of air propellers, the strength and suitability of materials, and the complete elements entering into the longitudinal and transverse stability of an aerodyne,† considered as a whole, just so soon, and not before, can we reasonably expect the problem of aerial navigation to be really solved.

During a careful study of the history of aerodynes,

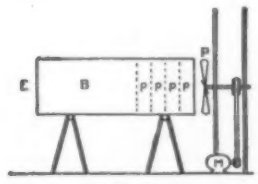


Fig. 2.

Fig. 3.

which I have followed to the time of writing (October, 1906), the fact that has most impressed me is that in every one of the proposed machines, both in the tried and untried ones, automatic longitudinal stability is not only a weak feature of the designs but is altogether absent in practically every case.

To a fairly satisfactory extent automatic transverse stability (by giving the aeroplanes a dihedral angle or by keels) is a solved problem, but not so automatic longitudinal stability. On this account I took up the laboratory study of aeroplanes with the aim clearly in view of finding if possible a type of aeroplane that should have *automatic* longitudinal stability. In this I have been most fortunate for I have found a type of double curvature aeroplane which not only possesses the elements of automatic longitudinal stability but also gives a very good "lift" and much reduced "drift" when compared with the single curvature surfaces most commonly employed and looked upon as our most efficient lifting aeroplanes.

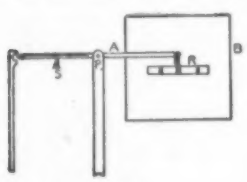


Fig. 4.

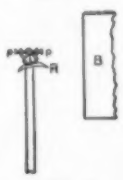


Fig. 5.

To make the study systematic let us divide all the possible (*simple*) aeroplanes into five types as follows:

Type I. The plane surface.

Type II. The single curvature surface, convex on the under side.

Type III. The single curvature surface, concave on the under side (the opposite of type II).

Type IV. The double curvature surface, concave at the forward portion, convex at the after portion, on the under side.

Type V. The double curvature surface, convex at the forward portion, concave at the after portion on the under side.

These are the only possible types (leaving out multiple curvatures of more than two) and we will take up the study of each individually and then compare the results.

In order to further simplify the problem and to make the results with the five different types strictly comparable with one another, I will deal only with surfaces having a rectangular plan-view and in which the width (at right angles to the air current) is twice the length (in the direction of the air current). While this method fails to cover the whole ground, since the number of possible plan-views is practically limitless, I feel assured that, *so far as general laws are concerned* the two-to-one rectangle is fairly typical of all forms.

Throughout the experiments, therefore, the five following planes alone are used: See Fig. 1, in which the common (developed) plan-view is shown at *A* and the various cross-sections along any fore and aft line *ab* corresponding to the above mentioned types are shown at *B*, *C*, *D*, *E*, and *F*. The arrow gives the direction of the air current.

In each case the (developed) length is 8.485 inches and the width is 16.97 inches, giving a two-to-one ratio with an area of 143.99 square inches or practically one square foot.

These five types were experimented with, first as to their "lifts" from 0 deg. to 20 deg., second as to their "drifts" from 0 deg. .to 20 deg., and third as to their longitudinal stability, or as to the position of the center of pressure at all angles from 0 deg. to 90 deg.

METHODS AND RESULTS.

General.

It is a well-known fact that the natural wind varies greatly (even from second to second) in intensity;* and it is even a difficult matter to obtain an artificial wind that has absolute constancy; in these experiments, therefore, in order that the results may be exactly comparable with one another, the writer employed a heavy four-bladed fan-propeller to produce a constant air current and this fan-propeller was driven by an electric motor whose current was from a storage battery of ample capacity. This fan-propeller was mounted at one (open) end of a rectangular box 6 feet long and 22 inches square and the speed of the propeller was so adjusted that the air current at the opposite (open) end was exactly ten miles per hour at a distance of one foot from the end of the box. In the box near the propeller and for the first half of its length thin "baffle-plates" were placed to avoid rotary air currents so that a practically rectilinear air current was produced at the experimental end of the box. The box was further raised from the floor about two feet and this is a most important point in such experiments, for if the box be placed on or near the floor the intake of the fan-propeller is unequal with a consequent inequality at the opposite end of the box.

Fig. 2 shows a side view and Fig. 3 an end view of the general arrangement of apparatus in all the experiments; in which *M* is the electric motor; *P*, the propeller; *B*, the long box; *pp*, baffle-plates, and *E*, the end at which the different apparatus for "lift," "drift," and center of pressure were placed.

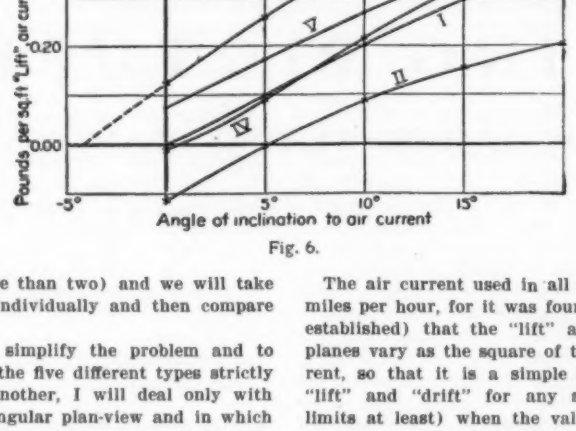


Fig. 6.

The air current used in all the experiments was 10 miles per hour, for it was found (as before frequently established) that the "lift" and "drift" of the aeroplanes vary as the square of the speed of the air current, so that it is a simple matter to compute the "lift" and "drift" for any speed (within ordinary limits at least) when the values for a certain speed are known. The variation (if any) for the position of the center of pressure, with different velocity of air currents, was not determined, as the system was not sufficiently flexible to obtain high speeds.

The aeroplanes experimented with were made of thin tin plate with only a sufficient number of ribs (three) on the upper side to make the forms absolutely rigid.

The original experiments were made in February to April, 1905, and were further repeated with refined apparatus in June and July, 1906.

"Lift" Experiments.

The apparatus for obtaining the "lift" (or vertical component of air pressure) of the aeroplanes, was mounted in such a way that the centers of the aeroplanes were one foot from the free end of the box and exactly in the middle of the opening.

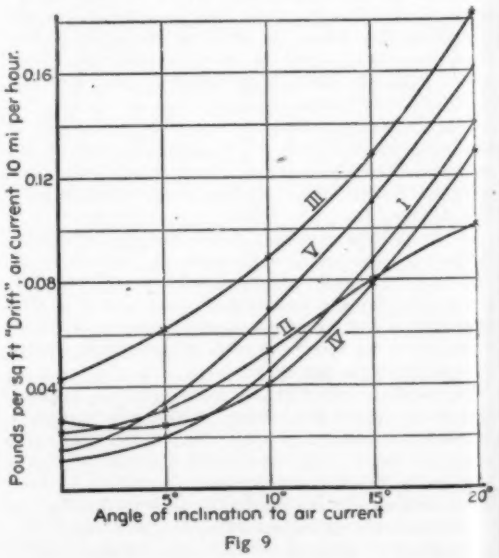


Fig 9

Fig. 4 shows a side elevation, and Fig. 5 an end elevation of this apparatus which is simply a common balance arm, *A* (mounted on horizontal pivots, *pp*), with the aeroplane, *R*, mounted on one arm, and with a movable scale-pan, *S*, on the other arm to measure the loss of weight when the air current passes.

Throughout the experiments the aeroplane, *R*, was inclined at angles of 0 deg., 5 deg., 10 deg., 15 deg., and

* Reprinted from the Physical Review.

† I use the word "aerodyne" in preference to "flying-machine," to denote an aeroplane-supported machine, driven by mechanical power through the air. I regret the introduction of a new term in the nomenclature of aerodynamics, but there is certainly a term lacking to express the required meaning, for "flying-machine" (Ger. Flugmaschine: Fr. machine volante) is too general and too suggestive of a wing-flapping machine; "aeroplane" (Drachenschweber, Fr. aeroplane) should apply not to the whole machine but to the supporting surface only (moreover, aeroplane is used to denote a soaring machine, etc., which is not power-driven) and "aerodrome" (the term used by Langley) while it is euphonious really denotes an *air course* in the same sense that hippodrome means a course for horse-races. "Aerodrome" in France is also used to mean a balloon-shed (compare Capt. E. Ferber, Revue d'Artillerie, Mars, 1904, also a letter by the writer in the SCIENTIFIC AMERICAN, September 22, 1906).

* Compare Langley, "The Internal Work of the Wind" (SCIENTIFIC AMERICAN SUPPLEMENT) and others.

20 deg. with the horizontal, and the corresponding settings of the scale-pan, *S*, to make a balance when the air current passes, were recorded.

In this way a series of readings were obtained which are plotted in Fig. 6, the average of several readings for each inclination of the areoplane being used to determine several points on the curves.

It will be noted that the *comparative** lift of Type V. at small angles is slightly greater than at large angles, by comparison with any of the other four types.

It will also be noted that the best "lift" (*per se*) is given by the single curvature surface, concave on the under side, and the poorest by the single curvature surface, convex on the under side; but, in selecting

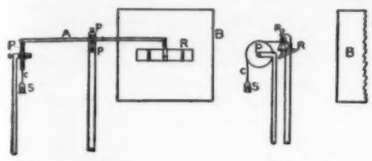


Fig. 7. Fig. 8.

the best form of aeroplane, for use in an aerodyne, other factors enter, as will be seen when these results are considered in connection with the "drift" and center of pressure experiments.

"Drift" Experiments.

The apparatus for measuring the "drift" (or horizontal component of the air pressure) was mounted in such a way that the center of the aeroplane was one foot from the free end of the box and exactly in the middle of the opening.

Fig. 7 shows a side elevation and Fig. 8 an end elevation of this apparatus, which is simply a balance arm, *A*, mounted on vertical pivots, *pp*, with the aeroplane, *R*, mounted on one arm and with the other arm attached to a cord, *C*, passing over a frictionless pulley, *P*. The scale-pan, *S*, in this case, being attached to the other end of the cord and the "drift" being measured by the adjustment of weights on the scale-pan.

As in the case of the "lift" experiments the aeroplane, *R*, was successively placed at 0 deg., 5 deg., 10 deg., 15 deg., and 20 deg. and the corresponding weights to make a balance, when the air current was passing, were recorded. For each reading the "drift" of the arm without the plane was subtracted from the reading. I might mention here that a compound balance (such as was used by Maxim in his experiments) for obtaining both the "lift" and "drift" with the same apparatus was first tried, but the method of employing separate pieces of apparatus for each form of experiment was found to be far more sensitive and accurate.

The data of the experiments on "drift" are plotted in Fig. 9, and on comparing them with the "lifts" of Fig. 6 we have some interesting results. It is noted that the single curvature surface (Type III.) concave

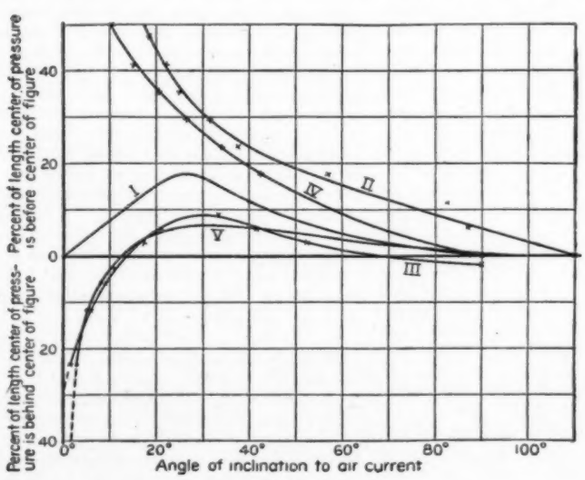


Fig. 12.

on the under side, not only has the largest "lift," but also the largest "drift," while the "drift" for Type IV. (concave in front, convex in the rear, on the under side) actually decreases from 0 deg. to 4 deg. For equal drifts we have the table given in the second following section and from this table we see that for equal "drifts" Type IV. at 10 deg. has more than double the "lift" of Type III. at —0.7 deg. This fact has more than usual interest, because it will be shown in the next section of this paper that Type IV. has automatic longitudinal stability from 90 deg. to 0 deg., while Type III. has longitudinal instability between the angles of 28 deg. and 0 deg.

The decreasing drift of Type IV. between the angles of 0 deg. and 4 deg. has also something to do with the soaring of birds, in the opinion of the writer, but this will be further referred to in another section.

In the two foregoing sections the writer has measured only the vertical component of air resistance ("lift") and the horizontal component of air resistance ("drift"). I have not followed Lilienthal's* method of plotting a resultant force (the total air resistance) from the "lift" and "drift" and afterward resolving this resultant into a "normal" and "tangential" force; for these latter mainly apply in the case of an aeroplane falling through the air at the same time moving forward along a course at a certain negative angle with the horizontal.

While Lilienthal's method is interesting when applied to his assumed slope of a bird's wing during the down-stroke, it is applicable only to artificial flight when it is sought to solve that problem by beating wings and it is, in general, not applicable to the problem of artificial flight with fixed aeroplanes driven horizontally through the air at a certain positive angle of inclination.

Center of Pressure.

Thorough in many ways as Lilienthal's results on "lift" and "drift" are, he unfortunately passed all too lightly over the more important question of the center of pressure, and while Joessel, Kummer, and Langley experimented on this all-essential problem, their experiments invariably stopped short of those critical angles between 25 deg. and 0 deg. which are by all means the important ones in the study of natural and artificial flight.

The first method used by the writer, for measuring the center of pressure, was the usual one of the eccen-

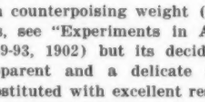


Fig 13.

tric plane with counterpoising weight (used by Langley and others, see "Experiments in Aerodynamics," Langley, pp. 89-93, 1902) but its decided limitations were soon apparent and a delicate counterpoising spring was substituted with excellent results, for aeroplanes whose centers of pressure advance far in front of their centers of figure.

The counterpoising spring is limited, however, to use with certain aeroplanes between about 35 deg. and 0 deg. so that a use of both methods is necessitated for a complete set of readings between 0 deg. and 90 deg.

The aeroplanes to be tested were ruled with lines (parallel to the leading edges) at distances of ½", 1", 1½", etc., in front of (and behind) their centers of figure and at the points where these lines reached the side edges of the aeroplanes screw clamps were successively placed. The clamps being provided with pivot-holes for the insertion of the pivots of the supporting frame.

Figs. 10 and 11 show front and side elevations of the apparatus as employed with counterpoising spring; *M* being the arm holding the supporting frame, *F*. *F* carries small arms which are adjustable along its length to allow of use with different widths of aeroplanes, and these small arms carry the pivots, *pp'*, which carry the aeroplane under test, *A*. The frame, *F*, also carries a vertical rod, *B*, to which is clamped at any desired height, the block, *E*. *E* houses a horizontal rod, *h* (adjustable horizontally), which carries at its end a long sensitive spring, *S*, acting as a counterpoise for the unbalanced weight of *A*.

S is protected from the air-current by a shield, *D* (V-shaped in plain cross-section), and a small pointer soldered to *S* plays over the scale, *i*, near the bottom of *D*.

The dotted line, *C*, Fig. 11, shows the (imaginary) chord of the curvature of *A* and in every case the upper side of the rib, *r*, is made parallel to this chord so that the angle which *A* makes with the horizontal

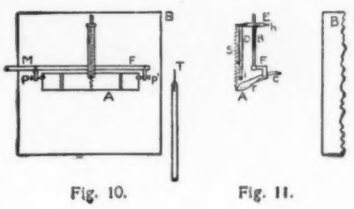


Fig. 10. Fig. 11.

may be read by means of a vertically mounted transparent protractor (shown in Fig. 10 at *T*) by sighting through the protractor along the upper line of the ribs.

When using the aeroplanes with a counterpoising weight the spring with its accessories was removed and the counterpoise secured by attaching a flat leaden weight to the upper side of the aeroplane under test.

Both methods of experiment were used as the circumstances of each setting of the pivots demanded and where the results of the two methods "overlapped" the accordance of the readings was satisfactory.

I have unfortunately been unable to obtain the original papers of Joessel and Kummer so that I do not know of their methods of experimenting, but Langley mounted his counterpoised eccentric planes on the arm of a large whirling table and obtained (from a pencil trace) the angle corresponding to a certain setting of the side pivots, and it is just here that the superiority of the method above described (with stationary aeroplanes and artificial air current) is most pronounced, for with several types of aeroplanes (viz., Types I., III., and V.) there is *not one angle but two* corresponding to one setting of the side pivots.

To illustrate this, let us take the example of plane No. III., with pivots on the center line; by Langley's method the only reading obtained is that at 90 deg.; by the writer's method the reading for 90 deg. is also obtained if the plane is untouched, but if the rear edge of the plane is supported loosely between the thumb and forefinger of one hand and carried to a position nearer the horizontal we find a second angle (at 12¾ deg.) where, if the plane be slightly depressed, the rear edge will be strongly depressed, and if slightly raised, the rear edge will be strongly raised, and we here have a second angle (capable of accurate measurement) *where the center of pressure again corresponds to the center of figure*. Of course, in place of the thumb and forefinger, a metal yoke with adjustable set screws could be similarly employed and could be vertically raised until this second critical angle was reached, but the thumb and forefinger furnish a sensitive index of the approach of this angle and the accuracy of the results are excellent.

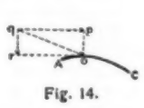


Fig. 14.

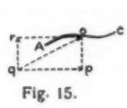


Fig. 15.

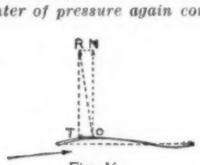


Fig 16

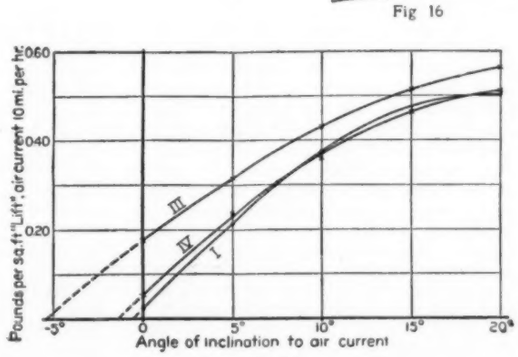


Fig 17.

The results of these experiments are given in Fig. 12 where angles with the horizontal are plotted as abscissæ and centers of pressure (in percentage of the side of plane), both before and behind the center of figure, are ordinates.

In the case of the plane (Type I) we note that the

* The writer has applied for patents in the United States, Canada, Great Britain, Germany, and France on Types IV. and V., but by an oversight on the part of the patent attorneys the word "comparative" in referring to the lift of Type V. was omitted from a part of the description, rendering the explanation of action absurd, as there is no known form of aeroplane which will give a *greater* lift at a *smaller* angle, for ordinary angles between zero and 30 deg.

* "Der Vogelflug als Grundlage der Fliegekunst," Berlin, 1889.

center of pressure steadily advances in front of the center of figure until the critical angle of 26 deg. is reached, when the center of pressure rapidly retreats to the center of figure as the angle becomes smaller and reaches 0 deg.*

In the cases of Types III and V this reversal takes place at somewhat near the same angle but at a much shorter distance in front of the center of figure. The center of pressure then rapidly retreats behind the center of figure, which it passes at about 13 deg.† Type III, on account of its excellent "lifting" qualities, is the aeroplane that has been almost universally used in artificial flight experiments, but this reversal in the position of the center of pressure with its consequent utter lack of longitudinal stability is doubtless responsible for nearly all the accidents that have occurred in aeroplane experiments; Lilienthal and Pilcher lost their lives through ignorance of this reversal and Langley's large machine was also probably wrecked through a lack of knowledge on this point.

For Types II and IV we have the remarkable result that the center of pressure steadily advances to the forward edge of the plane, where, by reference to Fig. 6, we note that the lifts are both negative. We therefore have, for these two types, *the condition of automatic longitudinal stability for all positive angles and "lifts."*‡

SIGNIFICANCE OF THESE RESULTS FOR ARTIFICIAL FLIGHT.

In comparing the relative merits of these five types from the viewpoint of artificial flight, we must not only take into consideration their stability curves as shown in Fig. 12, but also compare the "lifts" and "drifts" as given in Figs. 6 and 9.

We then find that for the two aeroplanes of automatic stability Type IV has a much superior "lift" to Type II and a lesser "drift" between the angles of 2 deg. and 15 deg., which are the important ones for artificial flight.

As pointed out above, Type III has been almost exclusively used in artificial flight, but when it is compared to Type IV we see that it has an utter lack of stability while Type IV has automatic stability, and while, at first sight, Type III has the superior lifting qualities it also has a large "drift." As a matter of fact, the "lift" of Type IV, as compared to its "drift," is superior to the "lift" of Type III, as compared to its "drift," *for certain angles* as per the table below, in which the respective values of "lift," at their corresponding angles, are given *for equal "drifts"* in each case.

Type IV		Type III.		Lift IV ÷ Lift III.
Angle.	Lift.	Angle.	Lift.	Ratio.
20°	.417	13.1°	.459	.91
19	.400	13.7	.439	.911
18	.381	12.4	.416	.916
17	.364	11.1	.395	.921
16	.346	9.6	.368	.941
15	.325	8	.331	.982
14	.303	6.3	.297	1.020
13	.283	4.6	.249	1.136
12	.261	2.9	.204	1.280
11	.240	1	.154	1.558
10	.216	0.7	.105	2.055

From this table it appears that *for equal drifts*, Type IV at 10 deg. has actually double the lifting value of Type III at —0.7 deg.

Lilienthal's principle for artificial flight was certainly well taken, viz.: "Stability first, propulsion afterward," but we cannot review the history of experimental aeronautics without insisting on this revision: *Automatic stability first and always*, propulsion so soon as prime-movers become sufficiently light.

Aeroplanes of Type IV give the essential elements of automatic longitudinal stability; the well-established principles of the "dihedral angle" and keels give automatic transverse stability; and gas engines, now approaching 3 pounds per horse-power, give the required lightness of prime movers.

In these three principles, therefore, the problem of aerial navigation is theoretically solved. It now remains only to so combine these three essentials, in practical form, to solve the problem from an engineering standpoint.

* In the case of a *square* with 9 inches side the writer found this critical angle at about 18 deg., and it is just about this point where the curves of Joessel, Kummer, and Langley (who all experimented with square planes) cease. Joessel inferring that the law formulated by him, $c = 0.3 (1 - \sin a) L$ held good until 0 deg. was reached.

† My results for Type III. agree fairly well with those of Spratt who, according to Moedebeck's "Taschenbuch fur Flugtechniker und Luftschiffer," 1904, p. 335, has not made his experiments public. Spratt's results as given by Moedebeck are these: for a single concave curvature surface of 1/12 curvature (shape not stated) the center of pressure at 0 deg. lies near the rear side, it advances as the angle increases, passing the middle point at about 17 deg., and advances to about 8½ per cent from the center of figure at 30 deg. It then moves in the opposite direction until it reaches the center of figure at 90 deg.

‡ Ahlborn, "Illus. Aeron. Mitteilungen," 1904, states *that only slightly convex* aeroplanes (Type II. of the writer's experiments) possess unconditional automatic stability, but his statement seems to be based on incomplete observations rather than on experiments.

I could hardly insist that aeroplanes of Type IV are the only ones possessing the all-important properties of automatic stability, but among simple aeroplanes (i. e., those having zero, single, or double curvature), my laboratory experiments have clearly shown that *Type IV is the only aeroplane having at the same time automatic longitudinal stability combined with excellent lifting properties and exceedingly small drifting properties*, for all angles that would probably be utilized in artificial flight.

Significance of These Results in Natural Flight.

Lilienthal in his valuable book* has given an able analysis of bird flight, but he has made one assumption (page 76) which is hardly tenable, viz., that the slightly concave surface is the form most like that of the bird's wing.

Neither my experiments nor a general consideration of the structure of the bird's wing lead to this conclusion.

The average cross-section of a bird's wing when extended consists essentially of a forward portion, *A*, Fig. 13, of rigid formation, with a central portion, *B*, of partial rigidity, and a rear portion, *C*, of extreme flexibility.

While this formation certainly varies from the portion nearest the body to the extreme tip of the wings, I think it will be generally conceded that Fig. 13 fairly represents an average cross-section of an average bird's wing (during the down stroke).

If now we conceive this wing in rapid up-and-down strokes passing through a resisting medium, such as the air, it requires only a rudimental conception of mechanics to infer that in the up stroke the cross-section assumes the form shown in *AC*, Fig. 14, while in the down stroke a form similar to that shown in *AC*, Fig. 15, would be necessitated.

In each figure, *op* gives the direction of the wing motion in each case, while *or* represents the absolute direction of the air current. It is obvious that the *relative* movement of the air particles is roughly represented by *qo*, and it is equally obvious that a wing of the type described in connection with Fig. 13, would be forced into the approximate forms shown in Figs. 14 and 15—*corresponding to the two Types II and IV, both of which have been shown by the laboratory experiments to have automatic longitudinal stability.*

If, then, we accept this reasoning, it is proven that in bird flight the two forms assumed by the wing *both have automatic longitudinal stability*, that in the up stroke the "lift" (negative in this case) is a minimum (see Type II, Fig. 6), while the "drift" is small (see Type II, Fig. 9), and that in the down stroke the "lift" is excellent (see Type IV, Fig. 6) while the "drift" is a minimum (see Type IV, Fig. 9).

From this it is seen that the laboratory experiments are in full accord and give a most rational explanation of the wonderful properties displayed in the flight of a bird.

For soaring or sailing flight the most probable form of the bird's wing is that shown in Fig. 16, which is simply a less accentuated form of Fig. 15, due to the lessened air pressure on the under side of the wing.

The resolution of forces as shown in this figure gives a perfectly rational explanation of soaring flight, by which a bird is supported and at the same time advances against an ascending current of air, for in working out the "lift" and "drift" under these conditions we find that *OR*, the resultant, is in advance of the normal to the chord of the double curvature, and we have for the forces acting upon the surface the vertical component *ON* equal to the weight of the bird and the tangential force, *OT*, which furthers, instead of hinders, the advance against the air current.

It has been frequently shown by delicate anemometer measurements, etc., that no natural wind is steady but that the natural air currents have a pulsating movement, with pulsations varying sometimes several times in a second. The soaring bird can instinctively feel these pulsations and can make excellent use of them by slightly inclining the extended wings more or less to the pulsating current, and can thus maintain or increase its height while at the same time it slowly advances against the air current.

Experiments from many sources (Lilienthal and others) have shown that there is also in natural winds, near the surface of land or water, an ascensional trend of about 3 deg., and this further facilitates the soaring of most birds.

Referring again to the automatic stability of birds, the extended tail in many species is undoubtedly a valuable *auxiliary* to the maintenance of automatic longitudinal stability; but it is quite evident from a consideration of several species in which the tail is almost lacking (e. g., the wild duck) that the tail is not essential, and this further accentuates the idea that the primal and main cause of automatic stability in bird flight is to be found in the wing-forms shown in Figs. 14 and 15.

* "Der Vogelflug als Grundlage der Fliegekunst," Berlin, 1889.

Lilienthal's close adherence to his conception of the natural wing form was the probable cause of his death, for in all of his soaring machines (and in a great majority of soaring machines that have since been built) the single concave surface has alone been used and with it of necessity (see Curve III, Fig. 12), automatic stability is impossible and "stability" is only obtainable by the agility of the operator in moving his body or an auxiliary steering aeroplane.

THE INFLUENCE OF AN UNDERPLANE.

In considering the subject of aeroplanes used in artificial flight it occurred to the writer that the lifting properties of aeroplanes might be considerably increased by allowing the aeroplanes to skim close to an underplane, such as a level piece of land or close over water.

As is shown in Fig. 17, a considerable increase in "lift" really occurs (due no doubt to the wedging action and consequent compression between the aeroplane and underplane) and at first sight it would seem a valuable consideration in the design of an aerodyne; since it is just when arising and alighting, when the speed would be comparatively low, that the maximum "lift" would be desired. However, many other modifying conditions must be considered, since screw propellers must have a considerable diameter and their central line of thrust must be in line with the aeroplane resistance; and, moreover, the "drift" is also considerably increased with an underplane and the center of pressure is shifted, in general, considerably farther "aft" than it would be in free flight, introducing serious difficulties in balancing. These various drawbacks of the underplane may be overcome (e. g., by superimposed planes), but it is well to draw attention to them.

In Fig. 17 the "lift" curves, with an underplane, are given for Types I, III, and IV. The readings with the underplane were obtained with the apparatus shown in Figs. 4 and 5 under the same conditions as before, but with an underplane (a large drawing board) placed horizontally one-half inch below the rear edge of the aeroplane in its mean position of balance.

It is needless here to go into details concerning the influence of an underplane on the "drift" and center of pressure of aeroplanes, but the writer's experiments with "lifts" may be summarized as follows: (1) With plane surfaces (Type I) and double curvature surfaces (Types IV and V) the *relative increases* of "lifts" with an underplane are greater than in the case of single curvature surfaces. (2) Under certain conditions the lift may be nearly doubled by an underplane very close to the rear edge, but in general, the influence nearly disappears at a distance above the underplane equal to about one-third the length (in the direction of the air current) of the aeroplane.

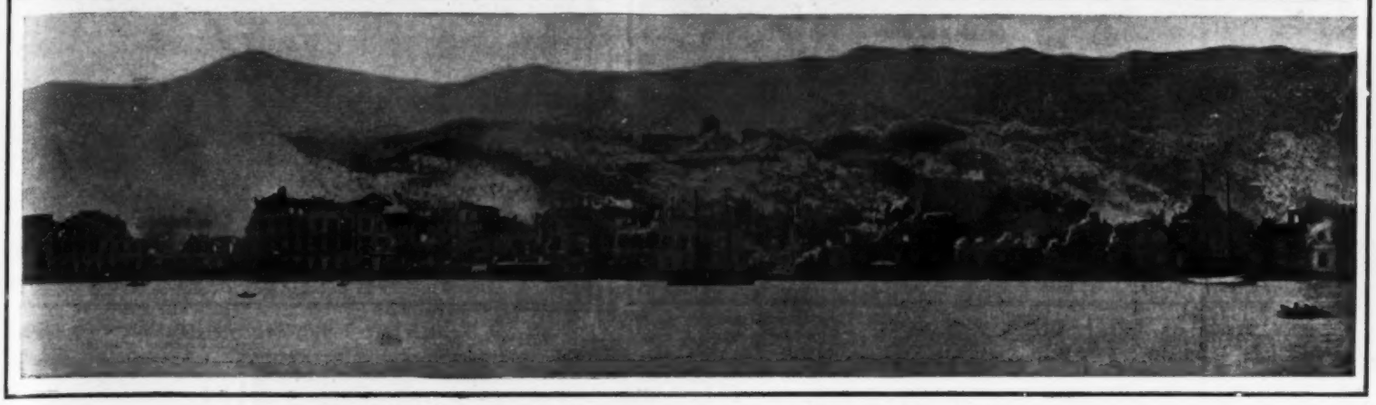
In conclusion, with regard to the general design of a practical aerodyne, I can only say that the proportion of parts is an essential feature which must be worked out by outdoor experiments, preferably over a sheet of water.

The laboratory experiments, described in this paper, can give but little help in the proportioning of parts, but they clearly show the type of aeroplane to be adopted and the type to be distinctly avoided. On the one hand we have Type IV, with its great advantages of *automatic longitudinal stability, excellent lifting properties and exceptionally low "drift"* and on the other hand, the long-adopted aeroplane with single concave curvature, which, while it has most superior lifting qualities, has also a most serious "drift" (for high speeds particularly to be considered) and *above all in importance, most treacherous longitudinal stability.*

A trifle in added speed gives the former type equal "lift" with the latter (since the lift and drift increase with the square of the speed), so that it should be an easy matter for a designer to choose unhesitatingly between the two.

It would appear that in view of the important discoveries of radium recently made in Saxony, the Saxon government has issued a decree, in accordance with which the right to search for and to extract minerals containing radium is retained by the State, which may, however, concede these rights to other persons. This decision has especial reference to the use of water from mines and springs giving rise to radium emanations, or containing dissolved salts of radium. Reference is made in this document to a number of springs rich in radium, notably to the waters of Georgenthal, in Vogtland, which yield 58.8 units of radium, as compared with the 47.5 units of the Karlsbad waters, or upward of one-third of the volume found in the richest springs hitherto discovered—namely, those of St. Joachimsthal. It is not intended to deprive private owners of their rights, but rather to regulate the production of radium, and by State intervention, to ascertain that the best means of utilization in the national interests are being adopted and carried out.

THE ITALIAN EARTHQUAKE.*



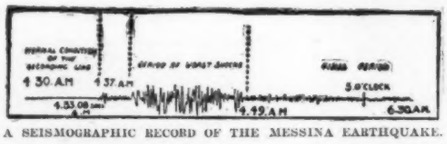
STRICKEN MESSINA; THE SMOULDERING RUINS OF THE CITY IMMEDIATELY AFTER THE CATASTROPHE.

NEVER had earthquake taken such toll of human life as that which has just devastated Calabria. Hundreds had been killed by a single earthquake, or thousands, exceptionally the number had run to tens of thousands, but the Yeddo—now Tokio—earthquake of 1703, with its death-roll of 200,000, had stood in a class by itself; yet even this great number seems insufficient to count the deaths on the morning of December 28, 1908, and if to those whose lives were ended by the immediate effects of the earthquake we add the subsequent deaths from injury, exposure, and sickness, the loss will amount to well over a quarter of a million lives.

In face of such a disaster humanity, staggered at first, has thought of nothing but relief or palliation, and the daily newspapers, filled with accounts of destruction, misery and rescue, have contained little information from which we can form a proper judgment of the nature of the shock or its magnitude. This much, however, is clear, that the earthquake was of the first order, not so great, perhaps, as the Californian or Chilian earthquakes of 1906, but far greater than the Calabrian ones of 1905 and 1907, and as great as either of the celebrated earthquakes in 1783, which caused 40,000 deaths in the same districts as have just suffered an even greater loss of life.

From Pizzo the band of destruction extends southward for about 50 miles through ill-starred Monteleone, which no earthquake seems to spare, Palmi, and Bagnara, to Reggio di Calabria. In Sicily, Messina has been destroyed, and Gazzi, but except from this narrow strip of country we have few reports. Catanzaro suffered, to what extent does not appear, and at Cosenza the damage was great; in Sicily, houses were destroyed in San Filippo, near Milazzo, and many were damaged in Caltanisetta and Noto, yet Catania escaped uninjured, and at Taormina only one building is said to have suffered any injury. The shock was felt, though slight, at Brindisi and Taranto, at Naples and Castellamare, and at Palermo the population fled in terror into the streets, though no damage was done.

From the interior of Aspromonte no news has come as yet, but the scanty information, summarized above, is enough to show that this earthquake, like most of those in Calabria and Sicily, was polycentric, originating, not from a single focus or centrum, but from a number of centers of greater intensity, the greatest of which lay close to the coast and for the most part beneath the sea. Moreover, it was no mere earth *quake*, but one of those great disturbances by which the whole world is shaken, which penetrate deep into its substance, and result in a permanent alteration of its shape. This would be sufficiently proved by the great sea wave which washed the shores of the Straits of Messina and the Tyrrhenian Sea, which swept over Messina and Reggio with a height of 30 feet, which caused three deaths at Catania and reached at least as far as Malta. This wave could only have originated in a great displacement of the bed of the sea, the nature of which is indicated by the narrative of the captain of the "Hopewell"; according to him, the boat, which was passing through the Straits at the time of the earthquake, seemed to leap into the air, as if a mine had exploded underneath her, and immediately afterward a mountain of water was heaped up to starboard and rushed furiously toward Messina, while soundings showed that the bed of the sea had risen ten feet. This last statement requires confirmation, and only careful and extended surveys can define the extent and nature of the displacements which have taken place; but, even without these details, the breakage of all submarine cables, no less than the sea wave, show that the earthquake must have been accompanied by the production, under the sea, of a "fault" or dislocation of the surface, such as is not an infrequent accompaniment of very great earthquakes.



A SEISMOGRAPHIC RECORD OF THE MESSINA EARTHQUAKE.

This record, taken at the St. Maur Observatory, Paris, on December 28, between 4:30 and 6:30 A.M., shows that the most intense shocks occurred in a period of sixteen minutes. The entire disturbance occupied two hours.

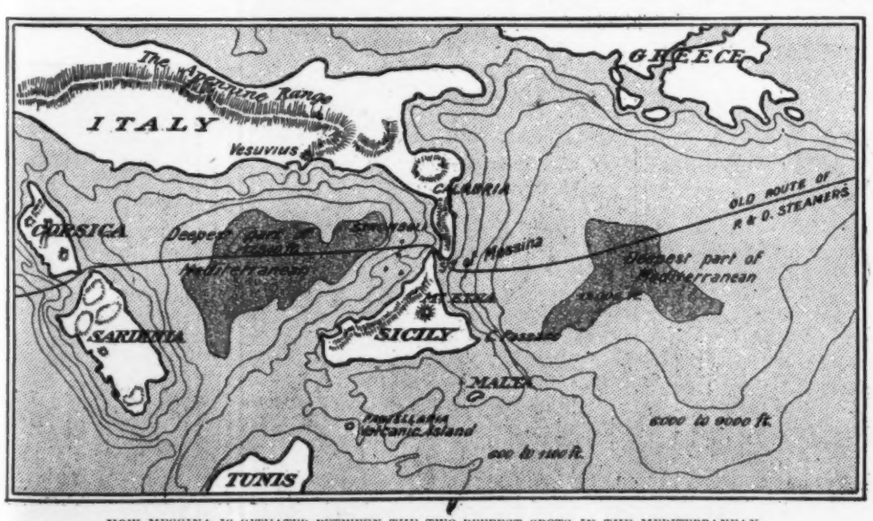
The most interesting and important question raised by this earthquake and its predecessors of 1905 and 1907 is whether the region may now look for respite or whether it is becoming unfit for human habitation, a question the answer of which requires a consideration of what is known of the cause of earthquakes and the past history of Calabria. Whatever may be the ultimate cause of an earthquake, there seems little room for doubt that it is of the nature of a gradually increasing strain, leading, in the end, to sudden rupture and the setting free of forces of which we still know little. Sometimes this strain will grow until the relief comes in a single great earthquake, with nothing visible or noticeable as a preparation or warning; in other cases we have had what, after the event, have been recognized as preparatory shocks. As an instance may be taken the Japanese earthquake of 1891, which gave rise to displacements along a fault-line 65 miles in length, and was preceded by minor earthquakes at either end of the line of this fault; it has been suggested, and the suggestion is plausible, that these gave partial relief to the growing strain, but that the ultimate effect of this partial relief was to equalize the strain along the line of the fault until finally no partial relief was any longer sufficient, and a general yielding resulted in the Mino Owari earthquake and fault.

Similarly, the shocks of 1905 and 1907 might be regarded as preparatory to the greater earthquake of 1908, and the supposition gains weight from the fact that they affected respectively the northern and the southern portions of the area in which the recent earthquake took its origin; but this interpretation suffers from the absence of any certain test by which we may know the preparatory shocks from the earthquake of which it is the forerunner, and be certain that the last of the trio is not itself preparatory to a still greater shock. Some light seems to be thrown on this question by the earthquakes of 1783; on February 5 of that year a severe and destructive earthquake ravaged much the same region as the shock of 1905; it was followed next day by an even greater earthquake, which, like the last, destroyed Messina, and was accompanied by a great sea wave; other lesser but still destructive shocks took place on February 7 and March 28. It will be seen from this that the events of the three days of 1783 were not unlike those of the three years of 1905-8, and the analogy bears closer examination, so we may conclude that, as the great cataclysm of 1783 was followed by a sixty years' respite from destructive earthquakes, and the lesser one of 1638 by a twenty-one years' respite, so the disaster of 1908, though it will be followed by a series of after-shocks, some of which probably will be severe, may reasonably be expected to inaugurate a long era of comparative repose during which the population will have time to recover. But so long as it consents, or prefers, to huddle together in towns and villages which, however gratifying to the artist's eye, are villainously built, and designed in defiance of every precaution which should be taken in an earthquake-shaken country, so long will every earthquake of any degree of severity result in loss of property and of human life.

AFFECTED AREA.

The sea-wall in front of the city of Messina has been broken up and has fallen, and the sea-walk has sunk under the water. Prof. A. Ricco, the director of the observatory at Catania, states that the docks and

* This article is reprinted from Nature. The illustrations are taken from The Graphic, Illustrated London News, Black and White, and the Sphere.



HOW MESSINA IS SITUATED BETWEEN THE TWO DEEPEST SPOTS IN THE MEDITERRANEAN.

Messina occupies a position roughly midway between the two deepest portions of the Mediterranean. At a distance of only about thirty miles from the shore of southeastern Sicily the depth of water increases to 12,000 feet, and similarly to the northwest of Messina there is another equally deep hollow. Messina is, therefore, situated at the summit of two long, steep gradients, a point of geologic danger. A long fault is stated to run along the Italian Riviera coast and along the slope of the Apennines to Calabria. In addition to Stromboli and the Liparis, Pantellaria island is of volcanic origin.

A RUINED HOME IN REGGIO.

TOP OF A WRECKED BUILDING IN REGGIO.

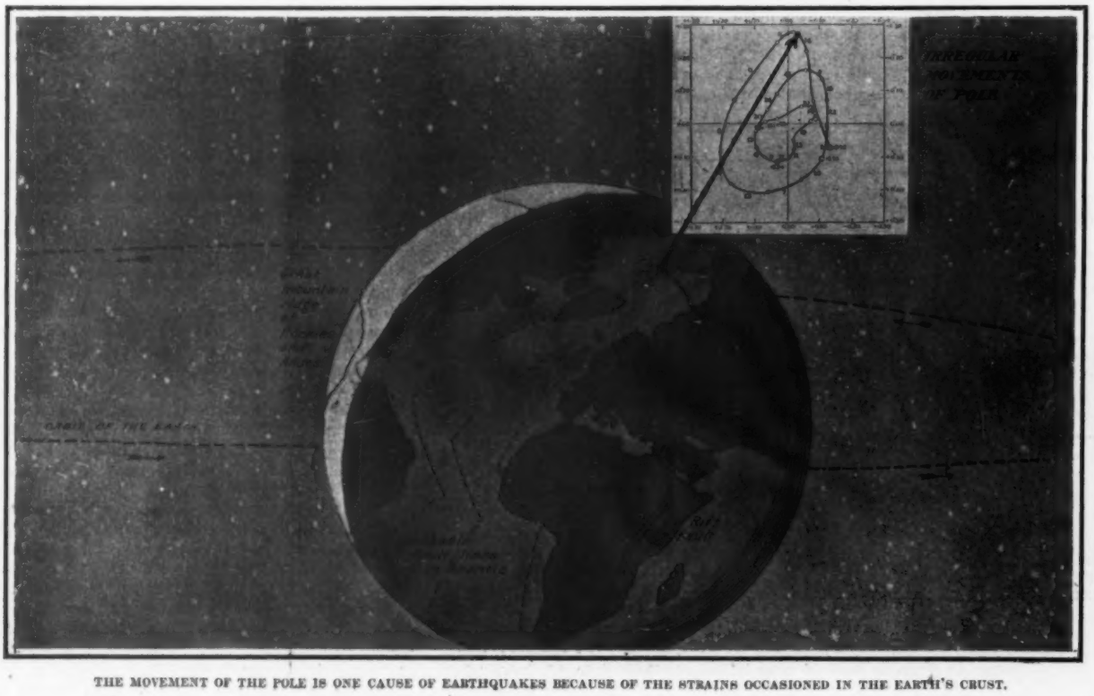
THE RUINED ESPLANADE.

INTERIOR OF THE CHURCH AT REGGIO.

THE COLLAPSE OF THE ESPLANADE.

PHOTOGRA[illegible] AT M[illegible]

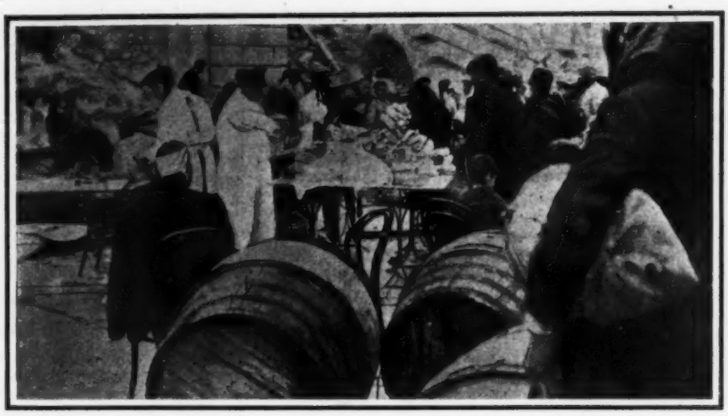
The shell of the house suggest[illegible]ng und[illegible]



THE MOVEMENT OF THE POLE IS ONE CAUSE OF EARTHQUAKES BECAUSE OF THE STRAINS OCCASIONED IN THE EARTH'S CRUST.

STROMBOLI—[illegible] NORTH[illegible]

SHATTERED ROOMS OPEN TO THE WEATHER IN MESSINA.



RUSSIAN NAVAL SURGEONS AT WORK AMONG THE RUINS.

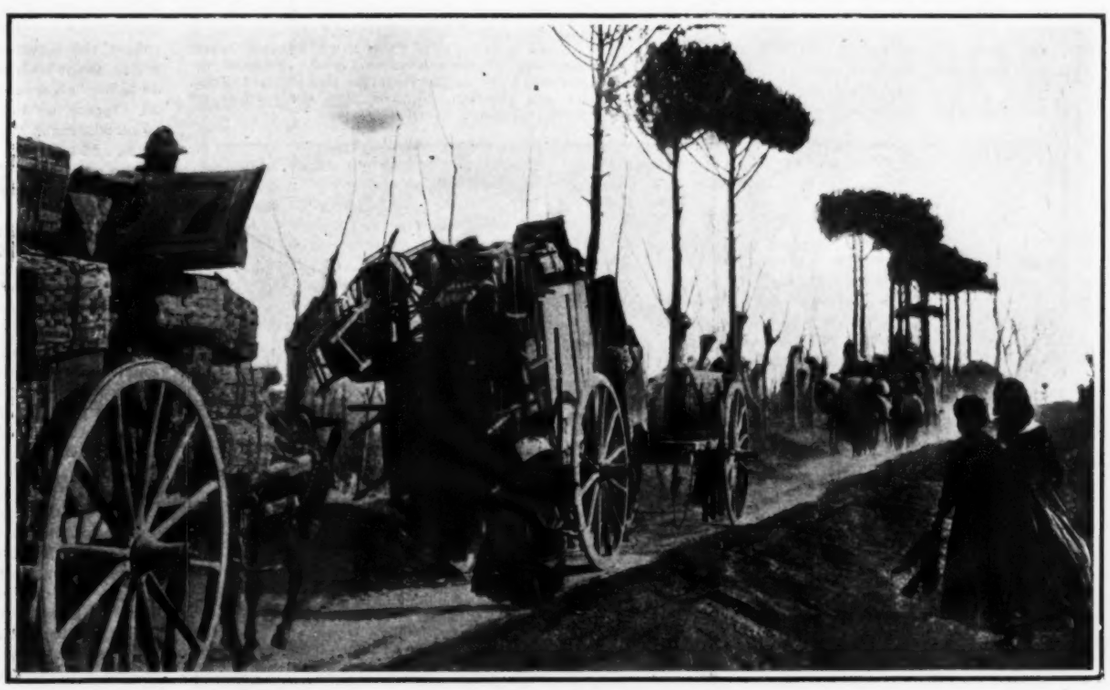
OTOGRA G AT MESSINA.
suggesti ng under the house-breakers' hands.

REFUGEES AT THE RAILWAY STATION.

IMPROVISED SHELTERS IN THE STREETS.

THE WRECKAGE IN THE VIA CAVOUR, MESSINA.

BOLI— NORTH OF SICILY.



THE FLIGHT FROM THE CITY.

IT HQUAKE.

other harbor works at Messina have sunk to the level of the water.

At Reggio the destruction seems to be even more complete than at Messina, for the whole of the city has been razed to the ground. The greater part of the sea front is under water. The whole area of the ground below Reggio seemed to have turned over, and a great part of the city is in ruins, covered by the sea. In many places deep chasms appeared in the streets. Of all the villages looking toward Reggio on the coast, not one has been left standing.

The prefect of Reggio states that the center of the town has settled down to the sea-level, and only the small villas on the promenade between Reggio and Campi, situated on the highest point of the town, remain standing. The sea front has been swept away, while the water inshore is blocked with sunken débris. Access by sea is impossible, and the town cannot be approached by land, as for a radius of eleven miles the country has a torn and twisted appearance, roads, bridges, foot-paths, and railway lines being uprooted. The face of the country has changed, and big fissures in the land have appeared.

The greatest damage was done in the low-lying and unfortunately most important portions, but both at Reggio and Messina this seems to have been due to the actual shock of the earthquake. The subsequent wave flooding the lower houses is said to have risen gently, and does not appear to have added much to the total damage.

In Reggio all the new houses of not more than 32 feet in height have resisted the shock completely. The houses along the Via Marina and the Corso Garibaldi on the sea front fell down to the first floor. Many of the old houses lost their walls on the side which faced the sea to the north. The new dwellings erected at Ferruzzano by the Milan Committee after 1905 have suffered no damage, though they were severely shaken; this is attributed more to the fact of their limited height than to their special construction.

The admiral-superintendent of Malta dockyard has requested the collector of customs to make it known that the statement that the Straits of Messina are unrecognizable is incorrect. The topography of the Straits is said by him to be unaltered.

A message from Rome on December 30 states that the submarine cable with the Ionian Isles is broken, and it is feared that the earthquake may have caused damage in the group.

The commander of a torpedo-boat, which was sent to inspect the Lipari Islands, has informed the ministry of marine that the shock of December 28 was very severe, and that several buildings were cracked, but that no one was killed.

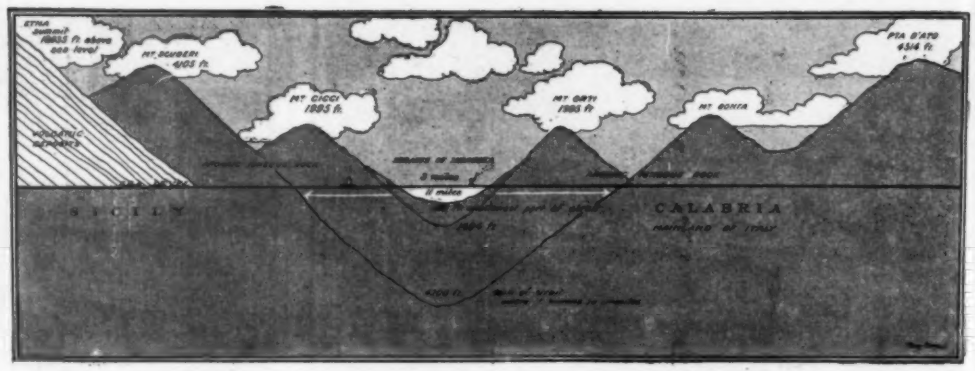
Prof. Ricco informed a correspondent of the Daily Mail that the earthquake had its maximum violence in Sicily and at the southern point of Calabria. The ruin spread from Castroreale, in Sicily, to Palmi, in Calabria, or a distance of forty miles. Damage to buildings occurred from Riposto and Patti, in Sicily, to Pizzo, in Calabria, a distance of eighty-six miles. The earthquake was felt violently from Mistretta and Noto (Sicily) to Cosenza (Calabria), a distance of 186 miles. It was felt, though only slightly, at Marsala and Trapani (Sicily), and even in Naples.

Taormina has escaped unscathed, except that the hotel San Domenico, occupying the site of the old Dominican monastery, has been somewhat damaged.

SEISMOGRAPH RECORDS.

The seismographic instruments at Laibach Observatory registered the earthquake at 5:22 and 6 A. M. Of twelve instruments, only one was able completely to register the successive shocks, as the oscillations were more violent than the instruments could measure. The maximum oscillation was registered at 5h. 26m. 16s. The seismic commotion noted at Ekaterinburg, and other observations, indicate that the wave of the disturbance moved southwest to northeast Europe.

The seismograph at Perth Observatory, Western Australia, recorded the earthquake, showing vibrations apparently at two periods of maximum intensity.

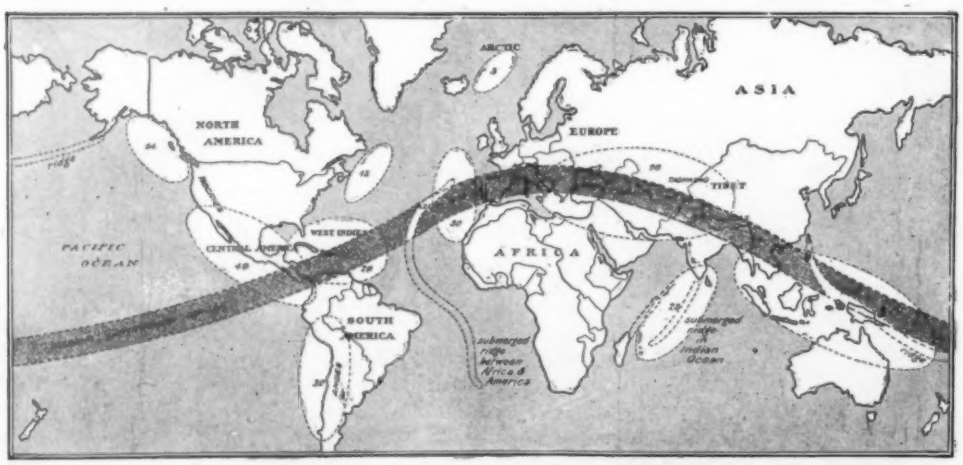


A SECTIONAL VIEW OF THE STRAITS OF MESSINA, SHOWING THE HEIGHTS AND DEPTHS IN THE IMMEDIATE NEIGHBORHOOD OF MESSINA AND REGGIO.

The above view shows sections of the Straits of Messina at three different points. Firstly, at the narrowest point where the depth only reaches 306 feet; further south, however, opposite Messina the depth rapidly increases to 1,494 feet, and still further south at a point where the straits are eleven miles wide the depth increases to over 4,000 feet. The heights on both sides of the straits form part of a really continuous mass, Sicily being in reality a pendant of the great Apennine range which runs down the length of southern Italy. Professor Milne has shown that the regions where great seismic and volcanic activities occur are to be found on the longest and steepest slopes.

THE EARTHQUAKE DANGER AREAS IN ITALY AND SICILY.

The map shows the main areas which are in more or less continual danger from earthquake shocks; the more unstable are shaded a darker tint. These it will be noted contain Reggio and Messina, others are on the slopes of the Apennines. Two earthquake areas also surround Mount Etna and Vesuvius. In these cases the shakings are derived immediately from the volcanoes.



HOW SOME OF THE CHIEF EARTHQUAKE AREAS LIE ON A BAND KNOWN AS "LIBBEY'S CIRCLE."

Professor Libbey has pointed out that a large number of the earthquake areas lie on a band forming a great circle. In the above diagram it will be seen that the earthquake areas of Central America, the West Indies, the Azores, the Caucasus, the Himalayas, and Western Polynesia all lie on this band. The Libbey circle is also cut by another line of earthquake activity running roughly north and south, namely, the line of the Aleutian Islands, the volcanic areas of North America, and the very active area of South America. The numbers given in each of the oval spaces indicate the number of large earthquakes which have originated in the various districts from 1899 to 1903. It will be noticed that two areas from which submarine earthquakes are reported—the Azores district and the Indian Ocean area—are both coincident with steep submerged ridges, and in the case of the district which includes Japan the island ridge of which that kingdom forms a portion is in immediate juxtaposition of an area of great ocean depth known as the Tuscarora Deep. An area off the Labrador coast is also in the neighborhood of a great deep.

THE ITALIAN EARTHQUAKE.

SUBSEQUENT DISTURBANCES.

A slight further shock was felt at Palermo on December 30. There was a more violent shock at San Marco Argentino during the night of December 29, accompanied by prolonged subterranean noise. Many houses were damaged, among them the church and the public buildings.

Shocks, less severe but always accompanied by subterranean rumbling, were felt in many places in Calabria during December 31.

Two earthquake shocks were felt at Algiers at about 6:30 P. M. on January 1. The shocks lasted about three minutes, and damaged some telephone wires.

Etna, Stromboli, and Vulcano were quiescent before and throughout the earthquake disturbance. On January 3, however, at 5:22 A. M., a violent shock of earthquake lasting three seconds was felt in the island of Stromboli. It was accompanied by an eruption of the volcano and prolonged subterranean rumblings. Buildings were seriously damaged, many houses being rendered uninhabitable.

At 11:44 P. M. on January 4 a shock of earthquake was felt at Tenerife, lasting twelve seconds. Bells were rung in the houses, and furniture was overthrown.

SUMMARY OF PHENOMENA.

The Rome correspondent of the Times gives the following details of the earthquake in telegrams on January 2 and 4: Among the phenomena which accompanied the movement the most notable is the wave which swept both shores of the Straits. The accounts as to the height to which the sea rose vary enormously. At Riposto, on the Sicilian coast, it was said to be 10 meters high. That seems to be an exaggerated estimate, and no doubt more exact knowledge will be soon forthcoming. All the survivors speak of the subterranean rumbling sound, which they generally describe as a dull roar that seemed beneath and around them, simultaneous with the first shock, and lasting during the subsequent shocks. Of the number, frequency, and violence of the subsequent shocks there are again very varying accounts. The apparatus in the Observatory of Mileto, Calabria, had registered twenty-eight shocks before it was destroyed. Vast fissures in the ground are reported at both Reggio and Messina. The weather conditions of those days have their significance. There was a marked depression in the extreme south of Italy two days before. On both December 27 and 28 it rained, and on the night of December 27 it rained in torrents. Rain fell again at intervals throughout Monday and Tuesday (December 28 and 29), and on the latter day it was accompanied by a violent wind.

Prof. G. B. Rizzo states that the action of the sea wave has been much exaggerated. In his opinion, the shock on the Sicilian side of the Straits caused a movement of water against the Calabrian side, followed by a re-flow against the Sicilian side and Messina, naturally with less violence. Very little loss, he thinks, was caused by the wave at Messina. What is really remarkable, and should be the object of careful study, is the raising of the level of the seashore; Prof. Rizzo noticed that several boats anchored some distance from shore were left high and dry. On the other hand, the ground has sunk in some places in the city, notably near the Municipal Palace and Via Seminario, where in one place it has fallen eleven yards.

LARGE GAS ENGINES FOR SHIPS.

THE POSSIBILITIES OF THE TWO-CYCLE, THREE-CYLINDER, FUEL-INJECTION ENGINE.

BY E. N. PERCY.

GAS producers for use on shipboard have been pretty thoroughly discussed, also the limits of sizes for gas engines, but all of these arguments have presupposed the present type of slow speed, high initial pressure, explosive engine. While the gas producer is getting to be fairly well understood, let us see if some more suitable type of engine could not be considered. We will assume a two-cycle, three-cylinder, fuel-injection engine as the coming type, for reasons detailed below.

Being two-cycle and three-cylinder, it can run at a high speed and be very light, for its power; especially as the fuel-injection type has no explosion, but a constant burning. This type starts easily with compressed air and reverses like a steam engine; in fact, handling just as easily. It would be a very simple engine, without gearing or valves, excepting a very small Stevenson link motion to control the fuel injection and air for starting.

The most successful engines of this type now manufactured exhaust at the end of a stroke through a port in the cylinder at one side, receiving the new charge through a port in the opposite side. The new charge is air only, and thoroughly scavenges the cylinder, some of it even escaping to make a clean scavenge; but this represents no loss of fuel, and a loss of power so small that it could not be measured. After compression, on the beginning of the return stroke, fuel (gas or liquid) is injected and burns, not explodes, until cut off by the valve gear. The fuel is ignited in any one of several ways; i. e., high compression, continuous electric spark, red-hot metal, or torch. The certainty and the control of these features will be apparent to any one, and, moreover, they are borne out in practice. In addition to this, we may borrow the idea from a well-known make and use the latent heat of the jacket water by letting it boil in the jacket, and after a pressure has accumulated, inject the steam into the cylinder with the fuel, where it acts in such a manner (as we know from fact, not theory) as to increase the economy and saves most of the jacket heat. The engines now on the market, made along the above lines, hold the records for economy, without exception, and in two instances have exceeded the ordinary engine by half; i. e., they take half the fuel. It might be well to notice here that the fuel-injection type of gas engine can be governed as accurately as a steam-engine; in fact, could be governed by a steam-engine governor, fly ball or shaft.

Assuming this to be one of three engines, driving a large triple-screw ocean steamer, let us consider the auxiliaries. First, there should be an independent gas engine, driving a small air compressor for starting purposes. There should be a large reservoir, holding considerable air, sufficient for several maneuvers, and a smaller reservoir, in case it has to be filled quickly for use. There will be an independent electric-light plant, run by small gas engines, to furnish power and light, and possibly ignition for the main engines. As it is very desirable to have the bearings and pins of a large marine engine perfectly accessible at all times, we could not expect to compress the charge of air in the crank chamber, since it is to be all open. Instead of adding a huge low-pressure blowing engine, we will merely have a small high-pressure electric blower, as two or three pounds is sufficient pressure. The fuel pump, or small compressor, if gas is used, will be coupled direct to the main shaft, as the fuel is never needed until after the engine starts, but if the engine is very large, a small drum to store the gas under the pressure may be used in conjunction with a separate auxiliary compressor, insuring always a supply of fuel to start on.

All the auxiliaries should be electrically driven, not only to do away with piping, but so that they can then be run from the dock by merely connecting with the dock power house, leaving the ship clear for repairs. All pumps will be electric centrifugal, as this type has been successfully used for feed pumps, and indeed for hydraulic pressures as high as 700 pounds per square inch.

With a ship of this description, very few firemen would be needed. There would be no more "cleaning fires," no more boiler repairs and no more stuffing boxes. The ship could be started at a minute's notice, without waiting to "steam up," or even "warmed up." Instead of compressed air, it might be found advantageous to have a large dynamo on the forward end of each main-engine shaft for developing power for the auxiliaries, the dynamos being used as motors, instead of compressed air for getting under way.

Steam from the jackets, or even generated in a small boiler, could be used for heating the ship.

The writer believes that it will be very hard indeed to increase the power of marine gas engines of the explosive type, but the fuel-injection type can be designed very much as steam engines, because their initial pressures are not high (excepting the compression-ignition type) and there are no explosions, hence no necessity for the enormously massive construction of the aforesaid type.

Furthermore, gas-engine designers do not seem to appreciate the advantages of multi-cylinder types, combined with high speed and several units; and naturally, when they try to put large power, and explosive power at that, in one large cylinder, that cylinder has to be very massive and very well supported, and experience shows the repairs to be more on this type than on a multi-cylinder engine of the same power and moderately fast speed, particularly if the latter engine is a single-action two-cycle engine, because the pressures are all in one direction, and there is no knocking of parts, no matter how loose they are.—International Marine Engineering.

THE GEOGRAPHIC CONGRESS.

THE ninth International Congress of Geography was held at Geneva in the beginning of August, and it was attended by 164 delegates and 750 participants. We will mention the leading resolutions which were adopted by the congress during the final meeting. The assembly adopted a resolution concerning the map of the world to the scale of one-millionth, and also resolutions as to the forming of an international map association. An international commission was appointed upon the proposition of Comm. Roncalgli, the delegate of the Italian Geographic Society, and it is to examine the following questions; first, to consider the organizing of an international bureau of geographic consultation for the benefit of commerce; second, to fix the programme and details of an international commission of delegates of the leading geographical societies and like associations, of the principal commercial organizations and of higher colleges of commercial instruction; third, to request the geographical societies to appoint delegates and to act as centers for the above movements as concerns the other institutions above cited. The following resolution was adopted upon the motion of M. Georges Lecointe, chief of the Uccle Observatory, Belgium: The international congress expresses the desire that the governments interested in the matter will give attention to the request which will be presented to them for adhesion to the international polar commission. This request will be made by the temporary bureau of this commission. M. Henry Arctowsky proposed a motion concerning the need of completing the systematic explorations of the polar regions, which was adopted. According to the report made by M. Nicolle, of the first section of the congress, the following resolutions were adopted: First, that France adheres to the system of standard time which is generally adopted, recognizing as the legal hour, the mean time of Paris retarded by 9 min. 21 sec.; second, that in all localities the hours of the day should be established from 0 to 24, from midnight to midnight; third, that all the clocks designed for public use including those placed in the interior of railroad stations, should be regulated to the legal hour. Upon the motion made by M. Eginitis, of Athens, it was proposed that the different governments should come to an agreement for realizing and completing the project of the Académie des Sciences and the Paris Bureau of Longitudes for the transmission of time and the determination of differences of longitude by radio-telegraphy. On sea this will be valuable for navigation, while on land it will be useful for astronomy, geography, and science in general. It was also proposed that the various geographical societies endeavor to interest the governments in the matter of restoring the maps of antiquity, Middle Ages and Renaissance, which have a great scientific value and which are likely to be destroyed by age. A commission was appointed for this purpose consisting of Drs. Nordenskjold, Miller, and others, in order to centralize the results obtained in this direction, and they are to present at the next congress a catalogue giving the general state of restoration of ancient maps in *fac simile*, and also to determine the order of importance in which it is desired to see the ancient maps restored. A motion was adopted concerning the establishing of an international committee in order to form a collection of reliefs of the earth's surface. The congress considers that it is of great importance and of urgent need at the present time in oceanographic work to carry out the physical and biological exploration of the Atlantic Ocean. The timely interest of such exploration of the Mediterranean, especially as regards fisheries, is undoubted. A special commission was appointed to convoke a technical conference in which all the Mediterranean countries will be represented, in order to draw up a programme of such work and the methods of carrying it out. A commission of seven members was appointed for examining the question of the proper spelling of geographical names, and it is to act in concert with competent persons or societies, at the same time promoting a discussion of the subject in the special journal. This will be done in order to draw up a definite report so that the next congress may be prepared to make a definite decision on this question. The next geographical congress will be held at Rome.

A $500 PRIZE FOR A SIMPLE EXPLANATION OF THE FOURTH DIMENSION.

A FRIEND of the SCIENTIFIC AMERICAN, who desires to remain unknown, has paid into the hands of the publishers the sum of $500, which is to be awarded as a prize for the best popular explanation of the Fourth Dimension, the object being to set forth in an essay the meaning of the term so that the ordinary lay reader can understand it.

Competitors for the prize must comply with the following conditions:

1. No essay must be longer than 2,500 words.
2. The essays must be written as simply, lucidly, and non-technically as possible.
3. Each essay must be typewritten and identified with a pseudonym. The essay must be inclosed in a plain sealed envelope, bearing only the pseudonym. With the essay should be sent a second plain sealed envelope, also labeled with the pseudonym, and containing the name and address of the competitor. Both these envelopes should be sent to "Fourth Dimension Editor, SCIENTIFIC AMERICAN, 361 Broadway, New York, N. Y."
4. All essays must be in the office of the SCIENTIFIC AMERICAN by April 1, 1909.
5. The Editor of the SCIENTIFIC AMERICAN will retain the small sealed envelope containing the address of the competitor and forward the essays to the Judges, who will select the prize-winning essay.
6. As soon as the Judges have agreed upon the winning essay, they will notify the Editor, who will open the envelope bearing the proper pseudonym and containing the competitor's true name. The competitor will be notified by the Editor that he has won the prize, and his essay will be published in the SCIENTIFIC AMERICAN.
7. The Editor reserves the right to publish in the columns of the SCIENTIFIC AMERICAN or the SCIENTIFIC AMERICAN SUPPLEMENT three or four of the more meritorious essays, which in the opinion of the judges are worthy of honorable mention.

Prof. Henry B. Manning, of Brown University, and Prof. S. A. Mitchell, of Columbia University, will be the judges.

A NEW VARIETY OF GLASS.

THE glass works at Baccarat, France, have produced glass chimneys of remarkable properties for lamps used in coal mines containing much fire damp. Ten of these chimneys were placed in water, slowly heated to the boiling point and then plunged into water at 59 deg. F. Not one of the chimneys cracked. In another test, a chimney was applied to a Berzelius burner, the flame of which completely filled it. The flame was made intensely hot by using gas at a pressure of two inches of water, and by placing other chimneys above and below the one on trial, and separated from it by rings of asbestos, thus making a very tall compound chimney and a powerful draft.

Of twenty chimneys tested, not one broke during five minutes of this heating, or during or after cooling.

The Jena glass which is used for similar chimneys and has given less satisfactory results, is slightly alkaline silico-borate of soda with a very little lead and zinc, and possesses a very low coefficient of thermal expansion. The Baccarat glass makers endeavored, not to diminish the expansion, but to increase the elasticity. This they accomplished by adding magnesia and oxide of zinc to the ordinary Baccarat crystal glass, which contains much lead. The composition finally adopted is the following: 75 parts of sand, 13 of bicarbonate of soda, 9 of carbonate of magnesia, 6 of oxide of zinc, and 50 of minium.

FLUID AND APPARENTLY LIVING CRYSTALS.

SOME RECENT DISCOVERIES IN A NEW FIELD.

BY PROF. ERNST SOMMERFELDT.

ABOUT ten years ago were discovered the first remarkable exceptions to the general rule that crystals are solid and rigid bodies. Until then it had been assumed that the designation "crystal" could not properly be applied to any other than a rigid body. This view is very ancient. The word crystal is derived from the Greek word for freezing, and Homer speaks of shields becoming covered, on a cold night, with "krystallos," that is to say, ice.

Probably this word crystal had something to do with the lively opposition which at first was provoked by the assertion that certain liquids exhibit the most essential properties of crystals, but as the investigations (made chiefly by Prof. Otto Lehmann) progressed, numerous states of transition between these two forms of matter, which had been assumed to be essentially different, were discovered.

Most crystals are distinguished from other transparent solids, such as glass or gelatine, by the optical peculiarity known as double refraction. Printed letters viewed through calc spar, for example, appear double. In many substances, owing to the impossibility of obtaining large transparent crystals, the property of double refraction can be discovered only by employing a microscope of special construction and by means of the colors produced by the interference of the two rays of light into which the incident ray is divided inside the crystal. By the same method, the property of double refraction can be detected in fluid crystals, or crystalline liquids, which may therefore be defined as substances which possess the optical properties of solid crystals, combined with the mobility and formlessness of liquids.

A closer approximation to true crystals is obtained by adding various substances to these simplest crystalline liquids. Lehmann has employed this method very extensively and with great success. The admixture causes the liquid to separate into parts, which are shaped according to the nature of the liquid, like drops, like crystal needles, or like worms. All of these forms exhibit a very strong tendency to move and to change their dimensions, by coalescence, subdivision, or absorption of the surrounding liquid. The drops usually rotate very rapidly, and both the drops and the needles or rods strongly resemble individual crystals, while the worm-like forms are so strikingly similar to living organisms that Lehmann has called them "apparently living crystals." This designation is rejected by many scientists, but it cannot be disputed that these lifeless bodies imitate with astonishing accuracy many of the vital functions of the simplest organisms. On the other hand, they differ totally from living organisms in being composed of comparatively simple molecules, instead of the exceedingly large and complex molecules of the albuminoids. The temperature necessary to the apparent life of the fluid crystals is very much higher than the highest temperature at which real life is possible. At ordinary atmospheric temperatures both the crystalline liquids and the "apparently living crystals" are ordinary solids. Their peculiar properties, in most cases, are manifested only at temperatures higher than the boiling point of water, and only within a small range of temperature, above which they become ordinary liquids which show no trace of double refraction.

The effects of overheating in the two cases are also very different. When a living organism is heated above the vital limit, its life is destroyed forever, but the overheated fluid crystals, on cooling, resume their apparent life when they again reach the temperature required for its manifestation, the process being completely reversible.

In regard to the colors produced by double refraction there is a difference between fluid crystals and solid crystals which has led some eminent chemists to the probably erroneous conclusion that the former are emulsions, or contain suspended particles. If a microscopic preparation of a solid crystal is rotated in its own plane by turning the stage of the microscope the colors vanish in certain positions, which are called "positions of extinction." Fluid crystals have no positions of extinction and the colors are not changed by the rotation of the stage. This difference, however, does not prove that there is no analogy between the two classes of substances. It may be explained by the assumption that the arrangement of molecules is not quite so regular in fluid as in solid crystals. A perfectly regular arrangement of molecules in parallel rows, as Huygens pictured in the case of calc spar, does not appear to be possible in fluid crystals, except in exceedingly thin strata under favorable conditions. Now, rapid changes of temperature are unfavorable to stability of molecular arrangement and it is found that when the necessary heating is accomplished very slowly and uniformly fluid crystals also have positions of extinction, in which the

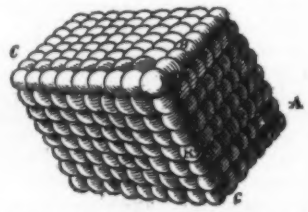


FIG. 1.—ARRANGEMENT OF MOLECULES IN CALC SPAR AS PICTURED BY HUYGENS.

interference colors disappear, as they do in the case of solid crystals.

Another very remarkable analogy between solid and fluid crystals was discovered by Vorlaender, a few months ago. Some preparations of doubly refracting solid crystals, when illuminated in the usual way with a parallel beam of light, do not show any double refraction, but appear isotropic, or singly refracting. But when these pseudo-isotropic preparations

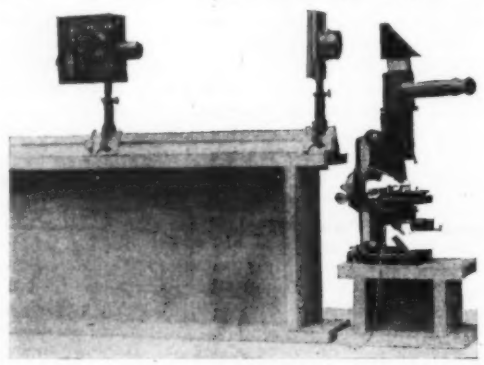


FIG. 2.—SOMMERFELDT AND SIEDENTOPF'S KINEMATOGRAPH-MICROSCOPE FOR MAKING MOVING PICTURES OF FLUID CRYSTALS.

are illuminated by converging beams of light rainbow tinted rings appear and prove that the crystals are really double refracting. Vorlaender has discovered that many liquids, hitherto regarded as singly refracting, are pseudo-isotropic and show colored rings when illuminated by conical beams of light.

The movements of fluid crystals are very interesting but their study is made difficult by the necessary conditions of high temperature, high magnifying

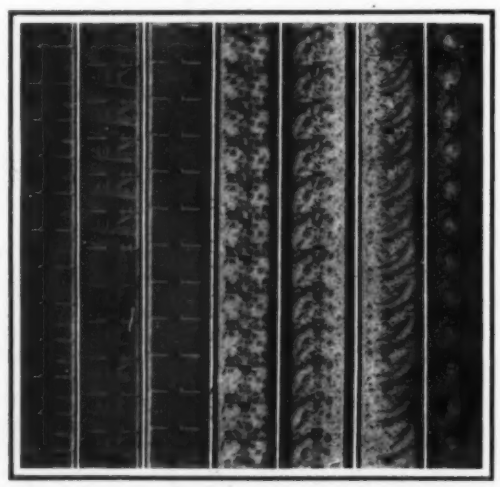


FIG. 3.—KINEMATOGRAPH FILMS OF FLUID CRYSTALS.

power and consequent lack of brightness. They can best be shown to lecture audiences indirectly, by means of moving pictures made with the aid of the kinematographic microscope, devised by Dr. Siedentopf and the writer. The microscope includes an eyepiece through which the crystals are viewed by reflection. This device is required in order to select a favorable moment for the exposure of the film. The image is sharply focused on the moving film by means of an auxiliary lens interposed between the microscope and the kinematographic camera.—Umschau.

MOVING PICTURES AS AN AID TO TEACHING TRADES.

THE present day conditions in manufacturing, which so seriously affect the education of young men in useful trades, are attracting wide-spread interest among educators, manufacturers, workmen, capitalists, and practically all who realize the difficulty of acquiring the skill and knowledge essential to any workman who aspires to be a master of his trade. The principle of manufacturing, as now conducted, is essentially antagonistic to the education of skilled workmen, except as specialists; but a condition which results in too many specialists and too few master workmen is detrimental to the trade.

There are many plans for the education of industrial workers, but none complete or entirely satisfactory, although all may have some very good features. The chief fault of most plans of industrial training is that the learner is removed from the commercial shop atmosphere if he receives the individual instruction desirable. If trained in the shop, he receives little individual instruction, the learner's interests being sacrificed because of the commercial necessity of promoting production.

The moving picture machine offers a partial solution of the problem of imparting individual instruction in the trades. Next to actually doing the thing or seeing a skilled workman do it, is the seeing of it done in a series of moving pictures. For example, take the operation of accurately filing a flat surface on a piece of cast iron held in a vise: A series of pictures showing the correct position and manner of handling the file could not help making a strong impression on earnest learners of the machinists' trade. The same method would apply to the operation of chipping with the hammer and chisel, scraping, lapping, laying out, and many other hand operations almost impossible of complete description without working examples.

In machine work, the moving picture scheme could be employed with even greater success. The operation of chucking a casting on the face-plate of a lathe and boring and facing could be shown vividly. Dozens of other operations shown in this way could be repeated indefinitely for the instruction of countless numbers of young men. They would be impressed by the methods illustrated and the spirit in which a skilled workman proceeds in doing the things portrayed. The first investment for films illustrating shop operations would be very heavy, and the plan must be worked out co-operatively in order that manufacturers may avail themselves of this system of imparting apprenticeship instruction cheaply. In our opinion there is merit in this idea as one feature of a general scheme of industrial education.—Machinery.

W. S. Richardson, in the Trans-American Chemical Society, reports on his microscopic investigations of frozen meat. A series of examinations extending over eighteen months failed to reveal any progressive change in the structure of the muscle-tissues. When meat is frozen the moisture collects around the individual muscle fibers, inclosing the same in ice, and thus barring off any microbes. According to the laws of solidification from solutions, since the solid separating out is practically pure ice, the residual solution left in the fiber must be very concentrated, and all indications are that microbes could not live in such a medium. In a communication to the Chemiker Zeitung Rosenstiehl writes of the influence of the particular character of the yeast and of the variety of grape employed upon the "bouquet" of the wine produced. The nature of the flavor depends on the kind of grape, but its strength on the yeast. Varieties of yeast which possess in a high degree the property of producing bouquet are termed "anthogenous." Grape juice contains a constituent, spoken of as anthophor, each variety having in general a specific and characteristic anthophor. The latter is present in good grapes, no matter whether they have grown in favorable locations or not, but the yeast, which develops the bouquet from the anthophor, ripens only in a favorable location. The best method of preparing a wine rich in bouquet is to sterilize the must at a temperature below 20 deg. C., and to ferment it with anthogenous yeast.

THE FEROCIOUS SAND VIPER.

HOW IT KILLS AND DESTROYS ITS PREY.

BY F. W OELZE.

IF we assume the primitive mode of feeding to be the simple seizure and swallowing of the living prey, as practised by the ringed viper, two ways in which the process can be improved suggest themselves. The victim might be crushed to death and into a form convenient for swallowing—an important point, for the ringed viper, despite the remarkable extensibility of its maw, often finds it impossible to swallow a large frog alive. Or, the victim might be killed by a poisonous secretion injected by biting with poison fangs. This is a refined and elegant method of inflicting death, in comparison with the brutal crushing practised by the great constrictor snakes, and it does not require so great a development of muscular power. Many insects adopt the same method, using stings instead of fangs. The blow-gun and poisoned darts (tipped with snake venom, by the way) of some South American tribes are more effective weapons than the Australian boomerang or the heavy assegai of the gigantic Zulu. So, too, are the rifle and shotgun of the civilized hunter, which likewise kill by causing a foreign substance to enter the body of the victim.

The most venomous of European snakes is the sand viper (*Vipera ammodytes*) of the Balkan region. (Fig. 1.) It attains a length of three feet or more, and is characterized by prominent eye ridges and a horny excrescence on the upper jaw, which give it a terrifying aspect. In reality, however, it is not ferocious, either in disposition or in manner, and when attacked, it calmly awaits a propitious moment and then strikes its fatal blow.

The photographs tell the story of a white mouse which was put into a cage where two sand vipers were resting on their perches. One of the snakes

FIG. 1.—SAND VIPER (VIPERA AMMODYTES).

yawned widely and repeatedly, and then began to glide slowly to the ground. The mouse, after a brief display of agility and curiosity, had become quiet and was calmly licking and grooming itself. The viper approached, lifted its head, arched its neck and showed its fangs within a hand's breadth of the mouse before the latter perceived it. When the mouse, at last, sprang away in terror it encountered the other viper and received a bite in the ear. Meanwhile the first viper approached, raised its head and buried its fangs in the mouse's side. The snake retracted its head to strike again, but the poison had done its work. The mouse quivered, rolled over on its side and, after a few convulsive twitchings of the feet, lay motionless and dead. The viper at once proceeded to lick the body all over, and then to swallow it, head foremost. (Fig. 2.) The sand viper is admirably constructed for swallowing large objects, as its jaws open until they form a right angle, and their edges have corrugations directed backward, which make it impossible for the object to slip out of their grasp. The gullet is capable of great distension. The danger of rupture is averted by a network of superficial sinews, which cover the body and connect the scales with each other. These sinews are usually invisible and even in the act of swallowing it is difficult to distinguish them from the general surface, but in a side light they make an impression on the photographic plate by means of their shadows. (Fig. 3.)

The viper first worms its lower jaw under the prey, so that its head resembles that of a pelican catching fish. (Fig. 2.) The act of swallowing is very complex and difficult to explain, but both jaws probably work simultaneously, the upper jaw being thrust forward, little by little, and the lower jaw moving up and down and to right and left. In this way the prey is gradually drawn into the gullet.

In the case described, the second viper also attempted to swallow the mouse, beginning with its hind quarters, but was shaken off, and the first viper soon assumed the appearance of Fig. 4, with paunch distended and only the mouse's tail still unswallowed.

The time which elapses between the bite and the death of the mouse varies greatly. It is usually from fifty to eighty seconds, but in some cases it is protracted to two, three, or even four minutes, while in others death is as instantaneous as death caused by lightning. The act of biting, or striking, is performed so quickly that no one has yet succeeded in photographing it. The operation of swallowing occupies from seven to twelve minutes. In a very few cases I have seen the strongest of my sand vipers hold the mouse fast after the bite and proceed to swallow it immediately, beginning, in one instance, with the belly of the victim.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Kosmos.

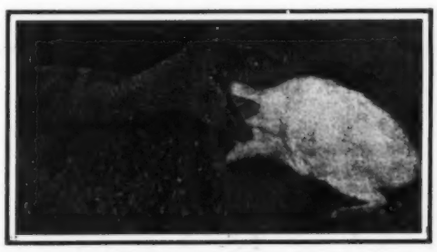


FIG. 2.—BEGINNING TO SWALLOW A MOUSE.

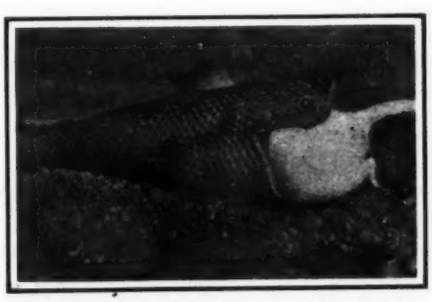


FIG. 3.—THE MOUSE HALF SWALLOWED.

LOMBROSO ON THE HAPPINESS OF LUNACY AND OF GENIUS.

PROF. CESARE LOMBROSO, of Turin University, the famous Italian alienist and criminologist who some years ago, in his book "The Man of Genius," set forth the correspondences that he believed existed between genius and insanity, has written an article entitled "Happiness in Idiots and in Geniuses," which may be found in the issue of the Roman Nuova Antologia. According to the American Review of Reviews, the professor here shows that supreme happiness is enjoyed by maniacs and by men of genius, a happiness far transcending the emotions of ordinary mortals, but that the duration of this blissful state differs strangely with the two classes mentioned. In maniacs, the feelings of great felicity endure permanently, indefinitely, while men of genius experience them only for the briefest moments. And he bridges over the distance between these two classes by a trait which he finds very common in them both; that is to say, megalomania. It may perhaps be well to note that Prof. Lombroso is usually considered as very much of a pathological experimentalist; this does not necessarily mean that he goes by guesswork, but his theories are not always of such a nature that they can be accepted as conclusive. Nevertheless, his ideas are invariably interesting and provocative of thought and discussion; "The Man of Genius" was attacked and defended all over Europe.

Pleasure is usually a fugitive thing, he commences; it lasts but a short time, and is followed by long periods of annoyance or weariness or regret. Pain, on the other hand, is more persistent and continuous, so much so that cessation therefrom is often accounted a state of enjoyment.

"Strange to say, the state of complete and lasting happiness, so foreign to sane persons, seems to exist in maniacs. Any one who visits a lunatic asylum for a few hours, where he hears desperate shrieking, imagines that he has come to a place of suffering. But after remaining there for some little time, you agree that only there can be met a type of happiness so prolonged and so complete as to offer the key to the condition of joy that is so extremely fleeting in normal beings. . . . The most common delusion of one afflicted with progressive paralytic dementia is that of wealth: millions of *lire*, five hundred billions, all the money in the world, to the limit of the idiot's imagination and powers of arithmetic. But mostly the delusion of importance or greatness expresses itself in all manner of forms without particular cohesion. The idiot first boasts of his physical qualities and capabilities, his excellent singing, his enormous weight, his chest of steel, his speed that enables him to run a thousand miles a minute, his bodily secretions of fine wines and precious metals. The women boast of their beauty and of their husbands, who are princes and emperors. The very entrails of the maniac seem attuned to the height of festivity, as if through intoxication; and this air of perennial joyfulness radiates externally from eyes shining with satisfaction in the height of conscious pride. . . . A man will brag of having dug a tunnel through the whole earth, of having slain ten lions, of singing bass, baritone, and tenor all at once; and he will promise you palaces and honors as the reward of a trifling favor or a kind word. To-day he is general of Europe, king of Rome and the stars; to-morrow he will be pope, anti-pope, coin-specialist, and prime minister. And with the decline of his mentality his elation increases. A woman who was a hopeless case of paralytic dementia persisted in repeating on the two last days of her life, and even in the throes of death, 'Oh, how happy I am! How happy I am.'"

FIG. 4.—THE MOUSE SWALLOWED.

Then there are some peculiar lunatics afflicted with what is known as the circulating mania. For a few months in the year they manifest extraordinary activity and cheerfulness; they rush about transacting innumerable business affairs, they talk incessantly with a most exuberant flow of language, they display immense altruism. But all of a sudden they collapse, their energy leaves them, and their buoyancy as well; they take to their beds and refuse to speak to any one or to touch food. Instancing some men of genius analogously smitten who enjoyed periods of marvelous exuberance and buoyancy and creative fervor, which were succeeded by long fits of the most terrible, calamitous depression, the author cites the names of Poe, the philosophers Comte and Schopenhauer, the French poets Verlaine, Baudelaire, and Gérard de Nerval.

Stating that with megalomaniacs happiness is of yet shorter duration, because they are so sensitive on the subject of their ambitions, so apprehensive that these be opposed or thwarted, Prof. Lombroso passes on to some cases of geniuses who had megalomania. Tasso and Cadano wished it inferred that they were inspired by God. Mahomet declared openly that he was. Any criticism of their opinions they looked upon as extreme persecution. Newton was said to have been infuriated against his scientific contradictors. The poet Lucius would not rise when Julius Cæsar entered the Assembly of Poets, because he considered himself the better versifier. The poet Lenau, in an access of delirium, fancied he was King of Hungary. Wezel, a German novelist, conceived the idea of starting a bank and of making his own bank notes; he finally believed he was God, and gave his books the title, "Works of God Vezelius." The Princess di Conti, informing Malherbe that she could show him the most beautiful verses in the world, he replied: "Excuse me, I have already seen them; because if, as you say, they are better than any others, I must have written them myself." Victor Hugo was governed by the obsession of being not only the greatest

of all poets, but the greatest of all men, of all countries, of all ages.

But genius is also allied with melancholy:

"One might suppose that all of these, in their imagined greatness, would be the happiest of men. However, this is by no means the case, for the worm of the persecution idea gnaws at the most roseate visions of geniuses, as if they were actual maniacs. It is almost proverbial, this tendency to melancholia among most thinkers, which corresponds to their hyperesthesia. . . . Just because their sight reaches further than the ordinary, and because occupied with too sublime flights, they have not commonplace habits of mind, and because—like idiots and unlike people of mere talent—they are frequently unbalanced, therefore geniuses are despised and misunderstood by the majority, who do not perceive their points of contact with the rest of mankind, but who do see their eccentricities of conduct, and the fact that their views disagree with those generally accepted. . . . Every one remembers that Rossini's "Barbier" and Beethoven's "Fidelio" were hissed, likewise Wagner, and in our country Boito because of his opera "Mefistofele." 'There has never been a liberal idea,' writes the famous novelist Flaubert, 'which has not been unpopular, not a true thing that has not scandalized the multitude!'"

And as examples of melancholy associated with genius, the author reminds us of Giordano Bruno, the renowned philosopher and astronomer; Goethe, Burns, Byron, Cooper, Comte, the Italian dramatist Alfieri, and his compatriot, the essayist Leopardi. The professor also dwells upon the case of the Italian physicist and mathematician, Cardano, to exemplify the frequent connection of megalomania with the mania of persecution. Cardano, he relates, declared himself the seventh genius of creation, adding that only one was born every ten centuries; he asserted that he had learned Greek and Latin in three days, had solved 40,000 problems, and made 200,000 discoveries; he claimed to have risen again after death. This man was haunted by the notion that he had innumerable enemies, who were all conspiring against his life, and he accused the faculty of the Paduan University of attempting to poison him. Cardano was in the habit of wearing a suit and head dress of thick leather; in the daytime he would wear leaded soles weighing eight pounds, and at night would roam about armed to the teeth, his face covered with black cloth.

Yet there is compensation for those melancholic fits so frequent in celebrated thinkers and writers.

"Geniuses, indeed, enjoy moments of brief but supernal felicity. These are the moments of creative frenzy, which in so many respects resemble the psychic accesses of epileptics; only, since not an ordinary brain is being agitated by convulsions, but a great mind, instead of some atrocious bestiality or dark crime there results a work of lofty character. Beaconsfield writes that he feels as if there were but a step from intense mental concentration to madness. He says that he can hardly describe what he feels in the moments when his sensations are abnormally acute and intense, that everything about him seems to be alive, that he seems to be raving, and is scarcely sure that he really exists. Analogous are the confessions of Nietzsche and Dostojevski. . . . And the illustrious Beethoven says: 'Musical inspiration is to me that mysterious state in which the whole world appears to shape itself into a vast harmony, when every feeling and every thought I have seem to resound within me, when all the forces of nature seem to become instruments for me, when my whole body is seized with violent shivering and my hair stands up on end.'"

Thus, concludes Lombroso, "may complete happiness be found, by a strange contrast, only in the extreme condition of paralytic dementia and in that of genius creative." But in the first case it is enduring and sterile; in the other, spasmodic and fruitful.

RAPID PHOTOGRAPHIC PRINTING.

A DESCRIPTION OF A NEW PROCESS.

SINCE the introduction, during the seventies of the last century, of the sensitized gelatine emulsion process, which was first applied to plates and soon afterward to printing papers, from which has resulted a remarkable growth of photographic trade, little has been proposed that could be termed notable or revolutionary. The improvement most noticeable was the introduction about 1891 of gelatino-chloride print-out papers—the all-popular P. O. P. of to-day. It was first commercially produced in Germany, but did not come into general use until offered at a popular price by English manufacturers. It displaced very quickly and completely the albumenized papers, which until its arrival was practically the only printing process employed by the great majority of photographers. Since the introduction of P. O. P. a self-toning variety has been introduced, and has become a standard article of nearly every maker; but except for the production, first as "Velox," of so-called gas-light papers, akin to bromide, but less sensitive, more rapidly developed and giving more "contrasty" results, the past ten or fifteen years have witnessed no radical departure from these three standard descriptions of silver printing papers, viz., P. O. P. (ordinary and self-toning), bromide, and gas-light. It is therefore with considerable interest that the introduction of a new order of photographic paper has been watched. Though also a gelatine emulsion paper, it is at least as different from P. O. P. as was the latter from albumen, and while it may still be debatable whether it will similarly push P. O. P. from the field, yet there is no denying the fact that the radical difference between it and its contemporary rivals does provide advantages of which photographers, both amateur and professional, have been loud in their praises. It may be best to state the properties of the new paper, and then to consider the technical means by which these results are secured. Briefly, then, the "Ensyna" paper is about the rapidity of gas-light paper, but gives a range of tones from purplish black to warm brown or red. The color depends on the degree of exposure, and except for this, even excessive over-exposure has practically no effect on the print. The fixation requires only half a minute in a weaker hypo bath than the normal, and the washing process need not exceed two minutes. One print can thus be made in a little over five minutes from first to last.

In "Ensyna" the principle adopted resembles that of the very earliest photographic processes. Fox Talbot, in his calotype process of the year 1843, formed a latent image, the full development of which he brought about by the application of a solution containing nitrate of silver and a developing agent such as gallic acid—at that time the best-known reagent. The germ image on the calotype paper was gradually built up by accretion of metallic silver, deposited from the solution by the developer. This "physical" development, as it was called, has not been used in gelatine dry plate processes, except to a quite minor extent, but it is the method which is used in the new paper. There is this difference, however: Instead of providing the silver in a soluble condition in the developer, the latter contains a substance which exerts a slight solvent action on the silver compound in the paper, and so provides the silver necessary for the development of the latent image. The substance used for the purpose is ammonium sulphocyanide, and the developer including it is one part of the whole process, and is the patent (English No. 13,032 of 1905) of H. J. Mallabar. According to the specification, the developing agent thus used in conjunction with the solvent substance is metol.

It will thus be understood by those familiar with photographic printing processes that this developing process somewhat resembles that employed for gelatine printing-out paper. Numerous formulæ have been prescribed from time to time for the development of P. O. P. prints which have been printed to a very slight extent, in some cases only enough to show a very faintly visible image. Such developers consist of an agent such as metol, hydroquinone, or pyrogallic acid *plus* an acid such as acetic or tartaric, the function of which is to restrain the activity of the developing agent. The silver for the developed image is provided by the paper itself in the form of a soluble silver salt, but as the quantity of this silver salt varies in different papers, as does also the quantity of free acid, added to the emulsion as a preservative, the development of printing-out papers has never become a reliable process. It has, moreover, had the drawbacks of yielding prints of a disagreeable color, and of discoloring the backing of the paper. Photographers have frequently been urged by enthusiastic writers to adopt the process on the ground of its rapidity, but the system has nevertheless remained in the background.

In the case of "Ensyna" the conditions are different. The paper, to be described directly, has a certain fixed composition, the developer contains a certain fixed proportion of sulphocyanide and developing agent, and therefore regular results should be, and actually are, obtained. The presence of the sulphocyanide in the developer evidently keeps the liquid clear in use. So far we have dealt only with the developer, the use of which we must describe in treating of the manipulation of the paper. Before doing so the sensitive paper itself calls for consideration.

According to the packages, the process of the preparation of the paper is the subject of the patent of York Schwartz (English Patents Nos. 9993 of 1902 and 9855 of 1907). From these it is seen that the silver salt employed is silver phosphate. In making the emulsion in accordance with the patent specification a quantity of phosphate is mixed with the whole quantity of silver, such that insoluble phosphate of silver is formed, chloric acid and an organic acid being also present in the emulsion.

In the presence of colloidal substances, preferably gelatine, a considerable excess of alkaline phosphate, preferably phosphate of sodium, is mixed with nitrate of silver. It has proved best to use double the quantity of alkaline phosphate, which would be necessary to convert the silver nitrate into silver phosphate. To this mixture chlorate of potassium and citric acid are added, and for the purpose of rendering the photographic film more resistant, it may be desirable to add further a small quantity of chrome alum. Owing to the great excess of alkaline phosphate the whole amount of silver in the emulsion must be present in the form of insoluble phosphate.

To digress a moment, it may be pointed out that the solution of metol and sulphite mentioned in the patent specification as an instantaneous developer of the prints is evidently not intended to be used in the manner of the developer of metol and sulphocyanide of Mallabar's patent. This is clear from the specific description of it as a chemical developer. The use, however, of a silver phosphate emulsion in conjunction with a non-alkaline developer (e. g., of hydroquinone and sulphite) is the subject of a semi-secret process for the manufacture of a rapid paper giving sepia tones by direct development. Silver phosphate, however, is not an easy substance to use in emulsion work owing to the development of free nitric acid in its formation by double decomposition from sodium hydrogen phosphate. At any rate, paper of this kind does not appear to be made by any of the English photo-material houses.

The silver phosphate of the "Ensyna" paper is the cause of the yellow color of the latter, and is the cause, too, of the important quality of rapid fixation which the paper possesses. The strength of fixing bath advised by the makers is 10 per cent, or half that usually used for development papers. But a sheet of the paper dipped into the bath loses its color almost instantaneously, owing to the solution of the phosphate. On allowing a sheet of the paper (one-half of which has been dipped in the hypo bath for a few seconds) to lie in the air, it retains its pure white color, except at the line of junction with the unimmersed portion. Here the local excess of silver causes decomposition and separation of silver sulphide, but the test shows the rapidity of action of the fixing bath, and bears out what one would expect from the great solubility of silver phosphate in solutions of sodium hyposulphite.

In regard to the legitimacy of the makers' directions to wash the prints in running water or several changes for two minutes only, the question naturally arises as to whether such procedure in any degree imperils the permanency of the prints. It must therefore be kept in mind that the "Ensyna" image is not of the delicate nature of the gelatino-chloride and collodio-chloride print. It corresponds with that of a gas-light or bromide developed print, and probably more nearly approaches the composition of a pure silver image than does either of these. And as it has been repeatedly shown in practical work that a bromide print, if perfectly fixed, will not suffer as regards permanency from the most desultory kind of washing, it is reasonable to presume that practical trials will bear out the maker's experience that a two-minute washing suffices. Probably the hypo would not be completely removed in this time, but the makers would seem to take the view that the small residuum of hypo in the prints has been found not to affect their permanency.

Turning now to the practical employment of the "Ensyna" paper, it is not necessary to say much, as the procedure is very simple. The paper is loaded into the frames with exactly the same degree of freedom as regards light permissible with gas-light paper. The time of exposure may be a little longer than the average gas-light paper. The print is then placed in a dish, preferably one of a size larger than itself, covered with clear water, and allowed to remain until it is limp. The water is then poured off and the developing solution applied. The image comes up slowly but steadily, and while yet the print is a little under strength, the developer is poured off—the makers advise its use but once only—a little water poured on,

and the print allowed to gain its final strength in this. It is then placed in the fixing bath for half a minute, and then finally given its wash of two minutes—not that longer washing will do any harm.

The warmth of tone increases with the degree of exposure, and as has been already stated, the only effect of giving exposures up to several hundred times the correct time is to obtain prints of greater and greater warmth. In fact, the only way in which a print can be spoiled is by under-exposure. One greatly under-exposed becomes fogged by the developer before it gains proper strength, but even in such cases, an alternative to the making of another exposure is to develop freely regardless of fog, and to reduce with Farmer's reducer of ferricyanide and hypo. The tone produced by about the minimum exposure which will develop up without fog is very nearly that of a gold-toned P. O. P.; the warmer tones include very good browns and sepias, while the addition of a little alum solution to the developer, coupled with a liberal exposure, will give a Bartolozi red. If the bluish black of a gas-light print developed with metol-hydroquinone is required, an easy method is to use, in place of the water bath before development, a solution of potass. bichromate, which is faintly yellow.

The nature of the film deposit is such that ordinary photo low-grade papers may be substituted for those of the usual high grade, on which excellent results may be obtained.

Doubtless other necessary means to the working of the paper will be devised, but in the meantime the altogether distinctive qualities of the paper would appear to portend a departure from the methods which have suffered scarcely any modifications during the past ten or fifteen years. At any rate, the paper marks a definite departure in photographic manufacture, and confers corresponding facilities upon photographic workers.

(Note.—The working of the process is described in extracts from the Mallabar and Schwartz patents which follow.)

British patent to H. J. Mallabar, No. 13,032 of 1905. Developing, printing.

In the process of printing on silver chloride paper, the paper is printed to about one-third the depth required for the ordinary gold process, and then developed in a solution containing a chemical such as cyanide, sulpho-cyanide or iodide.

As soon as the free silver salt is washed out of the print, the silver is precipitated as an insoluble non-adhesive salt, instead of being reduced to the metallic state and deposited on the print as is usual. A suitable developing solution contains pyrogallol (or metol, hydroquinone, etc.) Alkaline bichromide to increase the speed of developing, an alkaline sulphocyanide, and citric acid or its equivalent is added to make the developer work evenly and to remove the bichromate stain. In developing silver chloride emulsion, coated on post cards, a small quantity of metabisulphite salt is added to the developing solution to prevent the post card from staining on the back. The chemicals are formed into tablets, one containing the reducing agent (4 grs.) with or without a neutral substance such as milk sugar, and the other containing the bichromate (1/30 gr.), sulphocyanide (¼ gr.), and citric acid (1 gr.) with or without neutral substances.

This invention consists mainly in using cyanides or sulphocyanides in the developer.

Another form which gives equivalent results can be obtained by a compound of pyrogallic acid and metol in the one tablet, and the bichromate of potash, sulphocyanide of potassium, and citric acid in the other tablet, proportion as follows:

Pyrogallic acid	3 1/2 grs.
Metol	1/2 gr.
Bichromate of potassium	1/60 gr.
Sulphocyanide of potassium anhydrous	1/4 gr.
Citric acid	1/2 gr.

With or without inactive material such as sugar of milk.

British patent No. 9,903 of 1902. York Schwartz.

The present invention consists in emulsifying the phosphate of silver in gelatine solutions in the presence of chloride of silver and citrate of silver. Instead of citrate of silver, tartrate of silver can be used.

The following is an equivalent emulsion:

10.5 gr. gelatine dissolved in

A 80 c. cm. distilled water

1.19 gr. phosphate of sodium ($Na_2HO_3PO + H_2O$)

0.6 gr. chlorate of potassium.

B 1.7 gr. neutral citrate of potassium ($C_6H_5H_3O_7 + H_2O$)

0.4 gr. citric acid dissolved in

40 c. cm. distilled water.

C 5.2 gr. crystallized nitrate of silver dissolved in

10 c. cm. distilled water.

The mixing of these solutions is effected in the following way:

The solution B is added to the solution A, then 10 c. cm. of distilled water is added. Whereas solution C is added in small quantities to the mixture of the solutions A and B, the mixture being meanwhile thoroughly shaken. The above preparations are such that no free nitrate of silver is contained in the finished emulsion which consists essentially of the emulsifying agent, silver phosphate, silver chlorate, and a silver salt of an organic acid.

It is not necessary to fully "print out" these papers under the negative. It is only necessary to expose the same according to the density of the negative from 20 to 30 seconds to the action of daylight in order to obtain a picture which in daylight or with the usual lamplight can be developed in a very simple manner to any desired degree.

The developer consists, for instance, of a solution of

0.16 gr. of bichromate of potassium and

0.1 gr. of bromide of potassium in

500 c. cm. of distilled water, to which

50 c. cm. of which solution 30 drops of a solution of 2 per cent gallic acid in alcohol are added before using the same.

It will be clear that the emulsions may be used for manufacturing any kind of sensitive films for photographic purposes.

Attempts have been made to use phosphate of silver in the manufacture of photographic emulsions without using any halogenous silver compounds; these attempts have not been successful, as such photographs are not brilliant enough nor rich in contrasts.

British Patent No. 9,855 of 1907. York Schwartz.

The present invention relates to the production of a photographic emulsion as indicated in the specification of my British patent 9,993 of 1902. The emulsion as indicated in that specification consists essentially of phosphate of silver and besides the latter, of chlorate of silver and the silver salt of an organic acid, the two latter compounds being soluble, whereas the silver phosphate is insoluble. The sensitiveness of this emulsion has proved to be insufficient for certain purposes, and it is the object of the present invention to modify the emulsion of the kind referred to in such manner that the sensitiveness of the new emulsion is greatly increased as compared with the earlier one.

The emulsion proper for this purpose is prepared by using in the above-mentioned mixture the phosphate in excess, that is to say, such a quantity of the phosphate is incorporated that the whole quantity of silver is obtained or precipitated in the form of insoluble phosphate of silver, chloric acid. Organic acid being also present in the emulsion.

The process is as follows:

In the presence of the known colloidal substance, preferably gelatine, a considerable excess of alkaline phosphate, preferably phosphate of sodium, is mixed with nitrate of silver. It has proved best to use double the quantity of alkaline phosphate which would be necessary to convert the silver nitrate into silver phosphate. To this mixture chlorate of potassium and citric acid are added for the purpose of rendering the photographic film to be formed more resistant; it may be desirable to add further a small quantity of chrome alum. Owing to the great excess of alkaline phosphate it cannot be doubted that the whole amount of silver in the emulsion must be present in form of insoluble phosphate.

Every kind of suitable material may be coated with the emulsion.

The best developer for this emulsion is a simple aqueous solution of metol. The developers as necessary for the development of the emulsion prepared according to the patent specification above referred to, and being of rather a complicated nature, are entirely dispensed with.

The pictures developed by means of the aqueous metol solution show great intensity and brilliancy and very nice tones, and furthermore, great durability. By adding sulphite of sodium to the aqueous solution of metol the rapidity of development is so increased that it takes place nearly instantaneously, the development in this case being a chemical one. This method of development is preferably used for the negative process with this emulsion.

AN AUSTRIAN RAPID TYPE-MATRIX MACHINE.

CONSUL-GENERAL W. A. RUBLEE, of Vienna, has prepared the following report on a new type-composition machine invented in Austria:

An invention by which, it is claimed, book and newspaper printing will be placed on an entirely new basis has recently been patented by an Austrian inventor. The invention is not yet in use, but a model machine is at present being constructed and will soon be given a practical test. The invention is described by the inventor as a typewriting machine of peculiar construction that is provided with a contrivance for producing a matrix ready for the stereotyper without any additional hand or machine work. The machine therefore is considered far more suitable to the needs of a printing establishment than the present hand or machine typesetting methods. It is possible to use any kind of type in this new machine without resorting to complicated manipulation. The machine may contain 10, 20, 50, or more kinds of type without its being necessary to enlarge them materially. By the simple pressure of a key a different sort of type appears and the writing surface adapts itself at the same time to the size of the new letters, while the type are simultaneously stamped upon the matrix.

The straightening of the lines, as well as the regulating of their length and breadth, takes place without any difficulties, as well as the formation of the sentences. Corrections can also be made on the matrix, and the entire technical arrangement is harmonious and simple. By the use of a large number of keys provision is made for producing the more common syllables and word terminations by the touch of a key, so that one man can write from 50,000 to 60,000 letters in an hour, which is equal to more than 600 printed lines 18 centimeters (centimeter = 0.3937 inch) in length. According to present methods not one-tenth of this amount can be produced by a compositor in an hour. The machine can also be used advantageously as a typewriter, as it produces any kind of type with extraordinary rapidity. By its use an operator should be able to write from 70 to 80 words a minute, which is about the average of a stenographer.

RUSSIAN RAILROAD PROJECTS.

Two important railroad projects have been drawn up by the Russian government and they were approved successively by the Duma and the Imperial Council. These are the doubling of the Transsiberian line and the construction of a new railroad, the Amur line. Both of these undertakings are a consequence of the recent war with Japan. The doubling of the Transsiberian railroad is designed to remedy the insufficiency of the present single-track line, as now it only allows for the passage of seven trains per day in each direction. This limitation of the traffic was a great hindrance to military operations during the last campaign, and it is for these reasons especially of a strategic order that the adding of a second track to the railroad was decided. As to the new railroad in the Amur region, military considerations again mainly decided its construction. Seeing that by the treaty of Portsmouth, Russia was obliged to abandon the southern part of Manchuria, the eastern part of the Transsiberian line now lies in Chinese territory, and in consequence the traject of the railroad to Vladivostock is no longer made entirely on Russian territory. In this way the latter point can be cut off and isolated. It is in order to remedy this state of affairs that the new railroad line was decided. According to the present plans, the railroad starts from Karimskaia, near the Manchurian frontier, and it then follows the course of the Amur stream in a succession of curves, to Kabarosk. Thence it connects with the Oussouri line which lies near the coast. This line passes southward to the terminus at Vladivostock. A short section of the proposed line has already been constructed. As regards the present proposition in general, it met with some opposition on the part of the Duma, and in the Imperial Council the objections were still stronger. The adversaries of the government project brought out reasons which were mainly of a financial order. According to the official estimates the new line having 1,080 miles length would require an expenditure of $112,500,000, this to be distributed over four years. But it was thought that this figure was too low, and that the actual expense would not be less than $200,000,000. To this amount is to be added the annual operating deficit of $11,000,000, according to certain estimates, as well as the military expenses for the protection of the new line. These latter cannot be estimated with certainty, but it is considered that they will exceed $160,000,000. These financial objections were well brought out in the Imperial Council by Count Witte. Other objections were made as concerns the difficulties which will be encountered in the construction of the line as it traverses some regions which are inhospitable and but little explored, covered with dense forests and marsh ground which it will be almost impossible to clear. The construction will be attended with great difficulties, seeing that it is required to cross or pierce through mountains of a rocky character, as well as to provide for the usual freshets in the Amur River at the periods of thawing; it is found also that bridges of large size must be constructed at several points. It is also considered that the government project is the manifestation of a policy of economic and military expansion which caused the recent war, and the unfortunate results of the latter required these to be abandoned. However, the government insisted in favor of the project, which M. Stolypin represented as a national enterprise of great importance. He brought out the fact that the strategic considerations upon which the project is founded do not imply a belligerent policy, and that the construction of the line will be in accordance with the civilizing work pursued by Russia in the extreme Orient. The diffi-

culties of the enterprise are not insurmountable, and the Oussouri valley is called upon to take a considerable agricultural development.

SCIENCE NOTES.

C. Koehler, in German patent 202,741, claims a process for the manufacture of a food preparation from eggs, leguminous and other vegetables. This process consists in mixing yolks of eggs with such a quantity of ground peas, beans, or the like, that the fat of the yolks is completely absorbed by the meal. The product is then dried at a low temperature, preferably *in vacuo*, and is ground up with suitable vegetables (spinach), which have been previously steamed and dried with or without the addition of calcium phosphate.

In a recent number of the Popular Science Monthly Prof. A. E. Kenelly discusses the subject of the relation between record times and distances for different races, using as fresh illustrations the records of the Olympic games held in London. Prof. Kenelly shows that a linear relation subsisted between the logarithm of the record time for a race over a course of given length and the logarithm of that length. The Olympic records give points on the diagram lying close to, but above, the line determined by earlier records, the times being in every case relatively high. The divergence is most conspicuous in the case of the Marathon race, but this is not unnatural, as the conditions were scarcely similar to those of a race run over an artificial and almost strictly level course. Prof. Kenelly argues that records would be most easily beaten by the racer attempting to maintain until near the finish a uniform speed, equal to the average speed corresponding to the existing record, and suggests a mechanical method of pace-making for attaining this end.

M. E. Leger, of Paris, has produced a new organic compound from certain species of aloes. A body which he calls *aloésol* appears to be the base of the new compound, the *aloésol* being a complex phenol which has not as yet been isolated. By adding chlorate of potash to the solution of crude aloes from the Cape and from the Uganda region in hydrochloric acid, he obtains a body which can be crystallized in nearly colorless anhydrous needles, corresponding to the formula C_{11} H, Cl, O_3. He considers it as a tetrachlorated derivation compound of a yet unknown phenol to which he gives the name of *aloésol*. The present crystalline compound is of a rose color, and is quite insoluble in water; toluene dissolves it best, and it can be crystallized from this solution. Alkalis will also dissolve it, and in some cases there are formed combinations which an excess of alkali will precipitate as a gelatinous mass formed of microscopic needles. The new compound is found to melt at 268 deg. C., and can be sublimed at a higher heat. He obtains another body, the tetra-chlorated *acetyl-aloésol*, from the former; it consists of rather large prismatic crystals which are anhydrous and melt at 125 deg. C. Still another compound is the bichlorated *hydro-aloésol*, in the shape of crystalline grains which appear under the microscope as colorless needles. It melts at 275 deg. C.

Ozone-producing apparatus is now being used for disinfecting and for removing bad smells in ships and other places. It appears that electric apparatus for ozonizing water is now used in three of the German cities, namely, Berlin, Wiesbaden, and Paderborn. These plants serve to purify drinking water. This ozonizer is a modification of the Berthelot apparatus, and consists of a boiler or iron tank which is filled with water and contains three vertical glass tubes. These tubes project below the bottom of the tank through tight joints, and the lower ends are in contact with the air. Each of the tubes contains an aluminium cylinder. The air penetrates into the space between the cylinder and the tube and thus enters the tank at the upper part which is designed to contain the ozonized air. The aluminium forms the positive pole and the tank the negative pole of the current, which has a tension of 8,000 volts. The water in the tank becomes the outer coating of the condenser. An electric discharge takes place between the aluminium and the glass, which is of a silent nature. The iron tanks are connected to the ground by hollow iron columns which serve as supports. Placed together in a dark part of the plant, the boxes are mounted so that the operator can see the discharge through an opening. The air is first dried and filtered, and the water is also filtered. The ozone which is thus formed is led into the sterilizing towers, which are filled with gravel, and the water trickles down through this and comes in contact with the ozone. It is noticed that the ozonized water has a special taste and odor at first, but it loses this when passed in a masonry conduit. From 14 to 27 grammes of ozone per horse-power are obtained. Such water is very pure and almost free from bacteria, as has been determined. What germs may be left are of a harmless character.—The Steamship.

ENGINEERING NOTES.

The maximum thermal efficiency of the steam engine is 20 per cent; the maximum thermal efficiency of the gas engine is 40 per cent; their respective average efficiencies are 14 per cent and 28 per cent; consequently, the gas engine uses about half the fuel of the steam engine. But the efficiency of the steam boiler being about 70 per cent makes the ratio of 2½ between gas and steam engines about right.

The lateral thrust of wheels on rails has been investigated by the Schoen Steel Wheel Company, by means of a sensitive, self-recording apparatus. A 3-foot rail section was used on the outer rail of a curve of 1,307 feet radius. This piece of rail was held down firmly, but was free to slide outward slightly, pressing in the piston of a hydraulic cylinder in doing so. A small pipe connected this cylinder with a pressure gage registering up to 200 pounds per square inch, a recording pressure gage having the same maximum registration, and a pressure pump. The speed of the car was measured by a chronograph, the pen of which was momentarily lifted when the car passed by two trips or dogs a measured distance apart. The readings at medium speeds were erratic, but between 9.6 and 16.21 miles per hour the thrust of the wheel against the rail was very approximately equal to 333 V — 800, V being the speed in miles per hour. This expression gives the lowest values. None of the speeds recorded was equal to that corresponding to the super-elevation of the outside rail. The experiments indicated that a thrust against the rail amounting to nearly 21,000 pounds might be expected, and that the front wheel of the leading truck would probably exert the greatest thrust.

Among the interesting fuel tests which have been carried on during the past few years by the United States Geological Survey was a series of trials of low-grade fuels in gas producers. These tests indicated that many fuels of such low grade as to be practically valueless for use in boiler furnaces, including slack coal, bone coal, and lignite, may be economically converted into producer gas, and may thus generate sufficient power to render them of high commercial value. Coal containing as much as 45 per cent ash, and lignites and peats high in moisture, were successfully converted into producer gas, which was used to drive gas engines. It was found that the low-grade lignites of North Dakota developed as much power when converted into producer gas as did the best West Virginia bituminous coals when utilized under the steam boiler. In the fuel-testing plant, using the best Kanawha Valley coal, the steam plant produced 0.28 horse-power per pound of coal, and the gas plant 0.96 horse-power —3.43 times the efficiency for the producer-gas plant over the steam plant. The remarkable feature in these tests was the comparison between the Kanawha Valley coal under the steam boiler and the lignite in the producer-gas plant. The former under the boiler produced 0.28 horse-power per pound of fuel, while the lignite used in the producer-gas plant produced 0.30 horse-power, or 1.07 times the energy per pound of the best steam coal burned in the boiler furnace.

For three-high and for continuous mills, the electric motor certainly has strong features, making it preferable to the steam engine. But the future will see an increasing use of the gas engine coupled directly to large rolls. We should be able to design a gas engine for rolling-mill work and, for example, connect it to a series of continuous mills by a rope drive. The gas engine should be in a separate house so as to be protected from the dust and cinders of the mill. It seems to be one of the traditions of rolling-mill engineering that the engine must be in the same room with the mill. There are many rolling-mill engines where the main bearing cap has just one big hole for a piece of suet, which is the only means of lubrication, and, in case of heating, a stream of water is turned into the bearing. The electrical engineer, observing these conditions, has wisely placed his motor in a separate room, free from dirt and dust. But why can we not do the same with the engine? And why can we not design a gas engine free from that objectionable feature of the present type, viz., that it is very economical at full load, but not much better than a steam engine at half of maximum load? Why do our foremost engine builders insist upon following, absolutely and blindly, the Nurnberg type? The rolling-mill and blowing-engine types of gas engine will gradually leave the beaten path of the Nurnberg engine and will draw closer to the English type of scavenging engine which can be designed to allow of considerable overload. It will mean a considerable saving over the gas-engine drive with interposition of an electric transmission. The gas-engine-electric drive requires the engine, generator, motor, fly-wheel, then another generator, and a motor on the mill shaft; sometimes two or three motors on the mill shaft. In addition to all of this there is a lot of auxiliary apparatus, such as resistances, circuit breakers. The cost of all of this will run very close to three times the cost of a gas-engine and rope drive.

TRADE NOTES AND FORMULÆ.

Gloss Starch.—15 parts of boracic acid, 9 parts of borax and 3 parts each of stearine and white beeswax with the necessary quantity of soda lye, of 20 deg. Bé., are boiled until a fluid mass of uniform consistency is obtained and it is then evaporated to dryness. The product thus obtained is now mixed with the finest rice starch, in the proportion of 1 : 10, whereby a gloss starch is obtained, which imparts to the articles starched with it a high polish and great stiffness.

To Prevent Wood from Swelling through Dampness.—Dissolve, in a bottle containing half a pint of benzine, as much scraped paraffine as will saturate the benzine. With this solution coat the bare wood surface, in dry weather, by means of a hair brush. The benzine penetrates very quickly into the wood and takes with it so much paraffine that the outer surface is rendered very smooth and quite slippery. This process is especially adapted for windows, doors, and drawers.

Gliricin for Rats and Mice.—Fresh sea leeks (squills) are cut up and mixed with about half their weight of rye flour and as much fat, in a mortar, the whole being then passed through a so-called sausage machine. The mass presents the appearance of a brown-spotted, consistent electuary, and should be packed into tin boxes. Its effectiveness is only unquestionably established by its use in large quantities, and in large courts and buildings a quantity of 5 to 8 boxes (each containing about 25 ounces) will be required.

Gall Soap.—By boiling fresh or preserved galls with caustic alkali, or by boiling 2 parts of tallow or rosin soap with 1 part of gall, we obtain the gall soap used as a spot cleanser. For washing fine silk fabrics, ribbons, etc., Fichemont recommends a gall soap which is obtained by heating cocoanut oil in a copper kettle and mixing half a part of caustic soda lye of 30 deg. Bé. and half a part of white Venice turpentine. The mixture is kept hot for 4 hours, and then 1 part of oxgall is stirred with it. With the mass thus obtained from 1 to 2 parts of pulverized hard soap is mixed until it is perfectly hard.

Glycerine Cold Cream Soap may be made as follows: 3,000 parts cocoanut oil, 2,000 parts tallow, 800 parts castor oil and 200 parts of raw palm oil are heated to 167 deg. F. 3,000 parts of 36 deg. caustic soda lye is stirred into the above, with which is also mixed 200 parts of glycerine and 50 parts of spermaceti, the latter having been previously heated to 167 deg. F. The soap is then covered and left to spontaneous heat, which will have started in about 1½ hours. A clear, yellow, solid soap is obtained. The soap is now placed in molds and perfumed with 5 parts each of oil of cassia and oil of bergamot, 12 parts oil of lavender, 6 parts of tincture of musk, 6 parts tincture of benzoin, 2 parts oil of wintergreen, 3 parts oil of cloves, and 1 part oil of cinnamon.

Germania Ink.—100 parts of gall nuts, 15 parts of logwood extract, 30 parts of green vitriol, 2 parts of alum, 5 parts of vinegar, 1 part of carbolic acid, and 1,200 parts of water. The powdered gall nuts are placed in a tub having a discharge cock immediately above the bottom, 1,000 parts of water poured over them, the tub is covered and the mixture left to itself for fourteen days. At the same time, in separate vessels, the logwood extract is dissolved in 100 parts of water; in the remaining 100 parts of water the solution of the alum and the green vitriol is effected. After the liquid has been drawn from the gall nuts—as a rule it develops mold copiously—the carbolic acid and then the vinegar are added to the fluid. Finally, the iron vitriol and alum solutions are stirred in. We obtain in this manner a logwood ink of the most intense color; the ink is notable for its free fluidity, penetrates deeply into the paper, and is difficult to eradicate with the aid of chemicals.

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